

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

PARKER-HANNIFIN CORPORATION and)	
PARKER INTANGIBLES, LLC,)	
)	
Plaintiffs,)	C.A. No. 07-104(MPT)
)	
v.)	
)	
SEIREN CO., LTD.,)	
)	
Defendant.)	

**DEFENDANT SEIREN'S OPENING BRIEF IN SUPPORT
OF ITS MOTION FOR SUMMARY JUDGMENT OF
INVALIDITY FOR STATUTORY DOUBLE PATENTING**

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I. NATURE AND STAGE OF THE PROCEEDING

Three patents remain in this case – U.S. Patent Nos. 6,521,348 (the “‘348 patent”), 6,716,536 (the “‘536 patent”) and 6,777,095 (the “‘095 patent”) (Exhibits A, B and C, respectively) – brought by Plaintiffs Parker-Hannifin Corporation and Parker Intangibles, LLC (collectively “Parker”). The three patents are based on a series of continuation applications deriving from a common parent and are each directed to flame retardant EMI shielding gaskets.¹

Defendant Seiren Co., Ltd. (“Seiren”) has moved for summary judgment (1) that claims 1, 4, 5 and 8 of the ‘095 patent are invalid for statutory double patenting under 35 U.S.C. § 101, in view of claims 1, 4, 5 and 8 of the ‘536 patent, and (2) that claim 10 of the ‘095 patent is invalid for statutory double patenting under 35 U.S.C. § 101 in view of claim 8 of the ‘348 patent. This is Seiren’s Opening Brief in support of that motion.

II. SUMMARY OF ARGUMENT

The ‘348, ‘536 and ‘095 patent claims recite precisely the same gasket and differ only, according to Parker, in that the ‘348 and ‘536 patents claim a finished gasket in terms of its flame retardant content by *wet* weight at the time of manufacture, whereas the later ‘095 patent claims a finished gasket in terms of its flame retardant content by *dry* weight.

Seiren relies solely upon the wording of the claims, so there can be no dispute of material fact. Further, regardless of whether the Court accepts Parker’s construction of the claims or finds the claims to be indefinite as asserted by Seiren, the ‘095 patent claims are identical to the ‘348 and ‘536 patent claims and therefore invalid as a matter of law.

¹ Two other patents, U.S. Patent Nos. 6,248,393 and 6,387,523, were identified in the original Complaint but have since been withdrawn by Parker.

Claims 1, 4, 5, 8 and 10 are the only claims of the '095 patent asserted by Parker to be infringed by Seiren. (See Exhibit D, Parker-Hannifin Answer to Interrogatory No. 2). Accordingly, the grant of this motion would remove the '095 patent from the case.²

III. STATEMENT OF FACTS

Claim 1 of the '536 patent and claim 1 of the '095 patent both recite a "flame retardant, electromagnetic interference (EMI) shielding gasket." The gaskets of both claims are recited as comprising "a resilient core member," "an electrically-conductive fabric member," "a flame retardant layer." These elements and their relation to each other are identical in both claims.

A. The Parker Patents

1. The Claims

Independent claim 1 of the '536 patent recites

A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis,

said core member being formed of a foamed elastomeric material; an electrically-conductive fabric member surrounding the outer surface of said core member,

said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface,

at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween;

and a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprising at least about 30% by

² Despite the focus of this motion on the '095 patent, Seiren reserves the right to assert that the '348 and '536 claims are invalid because of obviousness-type double patenting.

weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

Similarly, independent claim 1 of the '095 patent recites

A flame retardant, electromagnetic interference (EMI) shielding gasket comprising: a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis,

said core member being formed of a foamed elastomeric material; an electrically-conductive fabric member surrounding the outer surface of said core member,

said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface,

at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween;

and a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprising at least about 50% by dry weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

Thus, claim 1 of the '536 patent and claim 1 of the '095 are identical, except that the former recites a flame retardant layer of at least about 30% by *wet* weight (according to Parker), which corresponds to a flame retardant content of at least about 50% by *dry* weight.

In the claim construction phase of this case, Parker argued that the flame retardant content of the '348 and '536 claims is a *wet weight*, i.e., that the flame retardant content of the flame retardant layer is based on the flame retardant emulsion as it is applied. Further, as discussed in greater detail below, Parker represented to the Patent Office that, because the emulsion has a solids content of 60%, a flame retardant content of 30-50% by *wet* weight corresponds to a flame retardant content of 50-83% by *dry* weight, and by implication, that a

flame retardant content of 30% by *wet* weight corresponds to a flame retardant content of 50% by *dry* weight.

Accordingly, these claims differ only in that the '348 and '536 claims define the flame retardant content of the finished gasket in terms of the wet weight of the flame retardant at the time that it was applied to the inner surface of the fabric member, whereas the '095 claims define that content in terms of the weight of the flame retardant after it has been dried. Thus, any gasket falling within claim 1 of the '536 patent would also fall within claim 1 of the '095 patent, and any gasket falling within claim 1 of the '095 patent would also fall within claim 1 of the '536 patent. Further, any gasket falling within claim 8 of the '348 patent would also fall within claim 10 of the '095 patent, and any gasket falling within claim 10 of the '095 patent would also fall within claim 8 of the '348 patent.

Parker may contend that the at least 30% wet weight limitation in claim 1 of the '536 patent, and the 30-50% wet weight limitation in claim 8 of the '348 patent, do not recite the same subject matter as the at least 50% dry weight limitation in claim 1 and the 50-83% dry weight limitation in claim 10, of the '095 patent, *i.e.*, that the '348 and '536 claims are limited to gaskets at the moment that the retardant emulsion is applied and before they are dried. In that case, Parker should not have sued Seiren for infringement of the '348 and '536 patents – the flame retardant emulsion of the Seiren gaskets is dried long before the gaskets are exported to the United States.

Dependent claims 4, 5 and 8 of the '536 patent recite identical subject matter as claims 4, 5 and 8 of the '095 patent.

2. The '348, '536 and '095 Prosecution Histories

The file histories of all three Parker patents place Parker's representations to the Patent Office during the '095 prosecution in context.

In an Office Action dated August 9, 2002, the examiner of the '348 patent application rejected the pending claims under 35 U.S.C. § 112, ¶1, because they were broader in scope than the specification enabled. The examiner asserted that the specification was enabling for gaskets in which "the flame retardant coating does not penetrate to the full depth of the fabric member, so as to retain the electrical conductivity of the side not penetrated by flame retardant composition." The examiner argued that the disclosure did not, however, enable one in the art to make *any* EMI shielding construction.

Additionally, the Examiner rejected the pending claims for obviousness-type double patenting over claims 1-8 of Parker's U.S. Patent No. 6,387,523. The examiner asserted that although

the conflicting claims are not identical, they are not patentably distinct from each other because claims 1-7 do not claim the depth of the fabric that is penetrated, as does [USP] 6,387,523. However, the specification of the instant application very clearly specifies that the fabric member has delimited the penetration by the flame retardant composition.

Parker responded to the rejection by limiting claim 1 to the scope of enablement found by the examiner in the specification. Specifically, claim 1 was amended to recite (1) that the resilient core member "is not V-0 rated under Underwriter's Laboratories (UL) Standard No. 94," (2) that "at least the exterior surface [is] electrically-conductive and the exterior surface [defines] with the interior surface a thickness dimension of the fabric member therebetween," and (3) that the flame retardant layer penetrates "into said fabric member to a depth which is less

than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.”

In their accompanying remarks, the ‘348 applicants implied that the amendment of claim 1 was in response to the enablement rejection. With respect to the obviousness-type double patenting rejection, applicants filed a terminal disclaimer.

Parker also referred to the recitation in new claim 8 of the flame retardant layer comprising between about 30-50% by weight of one or more flame retardant additives:

it is believed that the adhesive or other layers previously used in the art were not so highly loaded with flame retardant additives such that a gasket constructed therewith could achieve a UL rating of V) notwithstanding that the other component part thereof, namely the core, were not in and of themselves V0 rated. Rather, it is believed that conventional wisdom called for each of the components of the gasket to be V0-rated for achieving an overall gasket construction having a V0 rating. It remained for the instant Applicants, however, to recognize that a V0-rated gasket could be constructed without the core itself having to be V0-rated...

(Exhibit E, Amendment, October 21, 2003). The examiner then allowed the ‘348 patent application.

The prosecution history of the applications which resulted in the ‘536 and ‘095 patents raised similar enablement and double patenting issues. Parker addressed those issues by amending its claims in the same manner as in the ‘348 prosecution.³

³ Specifically, Parker amended the independent claims to recite (1) that “at least the exterior surface [is] electrically-conductive and the exterior surface [defines] with the interior surface a thickness dimension of the fabric member therebetween,” and (2) that the flame retardant layer (a) has the flame retardant contents recited in those patents and (b) penetrates “into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.”

Significantly, in its comments accompanying the claim amendment in the '095 application, Parker explained how the '095 specification supported the limitations of "at least about 50% by dry weight" in claim 1 and "between about 50-83% by dry weight" in claim 10.

Claim 1 also has been amended to recite that the flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprises at least about 50% by dry weight of one or more flame retardant additives. Support for the amendment may be found at page 10, lines 7-15 of the instant specification as filed,⁴ and further in the Example at page 15, lines 23-24.

In this regard, the specification describes [that] the 30-50% range is based on the total weight of the emulsion. With the emulsion having a total solids content of about 60%, such 30-50% range therefore corresponds to a dry weight basis in the dried or otherwise cured film of the layer [See Specification, at page 14, lines 4-8], of between about 50-83%. For example, at 60% total solids, 100 parts by total weight of the emulsion contains 30-50 parts of one or more flame retardant additives, and 60 parts by weight solids. On a solid or dry basis, i.e., with the 40 parts water having been removed, the total weight of the layer is now 60 parts with between about 30-50 parts thereof, i.e., about 50-83%, being the additive composition or concentration.

(Exhibit F, Preliminary Amendment, March 10, 2004; emphasis added). To obtain allowance of the new claims, Parker told the Patent Office that, for a given gasket, the flame retardant content of at least 30% when measured as a wet weight *equated* to a content of at least 50% when measured as a dry weight. Similarly, Parker asserted that the range of 30-50% when measured as a wet weight *equated* to the range of 50-83% when measured as a dry weight. That was based on a simple mathematical calculation – based on the 60% solids content. Because the '095 patent specification does not disclose the flame retardant in a dry weight of at least 50% or in the range 50-83% recited in claims 1 and 10, respectively, Parker needed to assert this mathematical

⁴ Parker refers, here, to 6:65-7:16 of the '095 specification which discloses "loading the emulsion with between about 30-50% by weight of one or more conventional flame retardant additives...." Parker asserts in its Answering Claim Construction Brief (at page 14) that "one of ordinary skill in the art would understand that 'about 30-50% by weight' and 'at least about 30% by weight' refer to the amount of flame retardant additive in the emulsion, i.e., the form of the coating at the time it is applied."

equivalence between wet and dry weights to establish support in the specification for the flame retardant content values recited in amended claim 1 and new claim 10.

Without such written description support in the '095 specification, the examiner could not have allowed the amendment of claim 1 or new claim 10 without the mathematical equivalence asserted by Parker. Should Parker now deny the equivalence of wet and dry flame retardant content values, the '095 claims are invalid under 35 U.S.C. § 112, ¶1, for failure to have written description support in the specification.

There is no indication in the '095 prosecution history that the examiner considered the overlap with the '348 or '536 claims described above.

IV. ARGUMENT

A. The Law of Summary Judgment

Although the question of whether a reference discloses each limitation of a patent claim is one of fact, it may be decided on summary judgment if the record reveals no genuine dispute of material fact. *See General Electric Co. v. Nintendo Co.*, 179 F.3d 1350, 1353 (Fed. Cir. 1999). The moving party is entitled to summary judgment "if the pleadings, the discovery and disclosure materials on file, and any affidavits show that there is no genuine issue as to any material fact and that the movant is entitled to judgment as a matter of law." Fed. R. Civ. P. 56(c); *Golden Bridge Tech., Inc. v. Nokia, Inc.*, 527 F.3d 1318, 1321 (Fed. Cir. 2008).

B. The Law of Statutory Double Patenting

The double patenting prohibition precludes a person from obtaining more than one patent for either (a) the "same invention," or (b) an "obvious" modification of the same invention. The defense of double patenting of the "same invention," the type relied on herein, is based on 35 U.S.C. § 101, which states that "[w]hoever invents or discovers any new and useful

process . . . may obtain *a* patent therefor. . . .” (Emphasis added). *In re Longi*, 759 F.2d 887, 892, 225 USPQ 645, 648 (Fed. Cir 1985). Thus, the term “same invention,” in this context means an invention drawn to identical subject matter, though, “claims may be differently worded and still define the same invention.” *In re Vogel*, 422 F.2d 438, 164 USPQ 619, 621 (1970). Thus, two claims may recite the same subject matter even though different wording is used.

C. The ‘348 and ‘536 Patent Claims Recite the Same Subject Matter as the ‘095 Patent Claims

The correspondence of the respective claims is shown below.

Claim	U.S. Patent No. 6,716,536	U.S. Patent No. 6,777,095
1.	A flame retardant, electromagnetic interference (EMI) shielding gasket comprising: a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis,	1. A flame retardant, electromagnetic interference (EMI) shielding gasket comprising: a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis,
	said core member being formed of a foamed elastomeric material;	said core member being formed of a foamed elastomeric material;
	an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface,	an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface,
	at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween;	at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween;
	and a flame retardant layer coating at least a portion of the interior surface of said fabric member,	and a flame retardant layer coating at least a portion of the interior surface of said fabric member,

Claim	U.S. Patent No. 6,716,536	U.S. Patent No. 6,777,095
	said flame retardant layer comprising at least about 30% by weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.	said flame retardant layer comprising at least about 50% by dry weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.
4.	The gasket of claim 1 wherein said fabric is a metal-plated cloth.	4. The gasket of claim 1 wherein said fabric is a metal-plated cloth.
5.	The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.	5. The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.
8.	The gasket of claim 1 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.	8. The gasket of claim 1 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

Claim	U.S. Patent No. 6,521,348	U.S. Patent No. 6,777,095
8.	A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:	10. The gasket of claim 1
	a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;	(See Claim 1)

Claim	U.S. Patent No. 6,521,348	U.S. Patent No. 6,777,095
	an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and	(See Claim 1)
	a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprising between about 30-50% by weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.	(See Claim 1) wherein said flame retardant layer comprises between about 50-83% by dry weight of one or said one or more flame retardant additives.

The only difference between the '348 and '536 patent claims, and the '095 patent claims, is in the recitation of flame retardant content in a wet weight as opposed to a dry weight.

As set forth above, however, Parker has admitted the equivalence of these values by suing Seiren for infringement of the '348 and '536 patents, even though Parker knew that Seiren's gaskets have never been exported to the United States with the emulsion in a wet condition. More importantly, to obtain allowance of its claims, Parker told the Patent Office during the '095 prosecution that, for a given gasket, the flame retardant content of at least 30% when measured as a wet weight *equated* to a content of at least 50% when measured as a dry weight. Similarly, Parker asserted that the range 30-50% when measured as a wet weight *equated* to the range of 50-83% when measured as a dry weight.

This double patenting cannot be avoided by the fact that one set of claims refers to wet weight and the other to dry, since the same gasket is defined in both cases. *In re Vogel*, 164 USPQ at 621 (“claims may be differently worded and still define the same invention. Thus a claim reciting a length of ‘thirty-six inches’ defines the same invention as a claim reciting a length of ‘three feet,’ if all other limitations are identical”). As Parker told the Patent Office during the ‘095 prosecution, for a given gasket, a flame retardant content of at least 30% when measured as a wet weight corresponds to at least 50% when measured as a dry weight, and a range 30-50% when measured as a wet weight corresponds to the range of 50-83% when measured as a dry weight, as a matter of mathematical calculation.

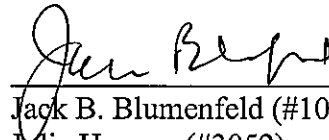
Also, for Parker now to reverse field, by asserting that the flame retardant content of at least 30% when measured as a wet weight *does not* equate to a content of at least 50% when measured as a dry weight, would mean that the ‘095 patent claims lack written description support because the ‘095 specification never discloses the flame retardant in a dry weight of at least 50% or in the range of 50-83% recited in claims 1 and 10, respectively.

Because there is statutory-type double patenting, as opposed to obviousness-type double patenting, Parker cannot cure the problem with a terminal disclaimer. MPEP 804, IIA; *In re Vogel*, 164 USPQ at 622. The consequence of statutory double patenting is that the later ‘095 patent claims are invalid.

V. CONCLUSION

For the reasons stated, Defendant Seiren requests summary judgment that claims 1, 4, 5 and 8 of the ‘095 patent are invalid for double patenting under 35 U.S.C. § 101 in view of claims 1, 4, 5 and 8 of the ‘536 patent, and that claim 10 of the ‘095 patent is invalid for double patenting under 35 U.S.C. § 101 in view of claim 8 of the ‘348 patent.

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CERTIFICATE OF SERVICE

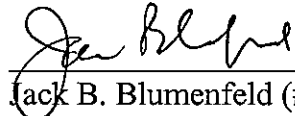
I hereby certify that on August 22, 2008 I electronically filed the foregoing with the Clerk of the Court using CM/ECF, which will send notification of such filing to:

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I further certify that I caused to be served copies of the foregoing document on August 22, 2008 upon the following in the manner indicated:

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EXHIBIT A



US006521348B2

(12) **United States Patent**
Bunyan et al.

(10) **Patent No.:** **US 6,521,348 B2**
 (45) **Date of Patent:** ***Feb. 18, 2003**

(54) **FLAME RETARDANT EMI SHIELDING GASKET**

(75) **Inventors:** Michael H. Bunyan, Chelmsford, MA (US); William I. Flanders, Merimack, NH (US)

(73) **Assignee:** Parker-Hannifin Corp., Cleveland, OH (US)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

4,531,994 A	7/1985	Holtrop et al.
4,540,617 A	9/1985	Kawanishi et al.
4,569,304 A	2/1986	Le Maitre
4,572,960 A	2/1986	Ebneth et al.
4,608,104 A	8/1986	Holtrop et al.
4,621,013 A	11/1986	Holtrop et al.

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

DE	9013936	12/1990
EP	0326441	8/1989
FR	2308030	11/1976
JP	07-176889	* 7/1995
WO	WO 00/23513	* 4/2000
WO	WO 01/10182	* 2/2001

OTHER PUBLICATIONS

Dye, James M. Compliance Engineering 17(3), pp 138 and 140-145, 2000.*

Kleiner, J. Vinyl Technol. vol. 4 No. 4, Dec. 1982, pp 157-159, 1982.*

Copy of the International Application Published Under the Patent Cooperation Treaty in International Patent Application No. PCT/US00/20609 (WO 01/10182) entitled: "Method and Apparatus for Manufacturing A Flame Retardant EMI Gasket".

(List continued on next page.)

Primary Examiner—Erma Cameron

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(57) ABSTRACT

A flame retardant, electromagnetic interference (EMI) shielding gasket construction. The construction includes a resilient core member formed of a foamed elastomeric material, an electrically-conductive fabric member surrounding the outer surface of the core member, and a flame retardant layer coating at least a portion of the interior surface of the fabric member. The flame retardant layer is effective to afford the gasket construction with a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

18 Claims, 3 Drawing Sheets

(21) **Appl. No.:** 10/142,803

(22) **Filed:** May 9, 2002

(65) **Prior Publication Data**

US 2002/0125026 A1 Sep. 12, 2002

Related U.S. Application Data

(63) Continuation of application No. 09/883,785, filed on Jun. 18, 2001, now Pat. No. 6,387,523, which is a continuation of application No. 09/250,338, filed on Feb. 16, 1999, now Pat. No. 6,428,393.

(60) Provisional application No. 60/076,370, filed on Feb. 27, 1998.

(51) **Int. Cl.⁷** B32B 5/14; B32B 5/18; H05K 9/00

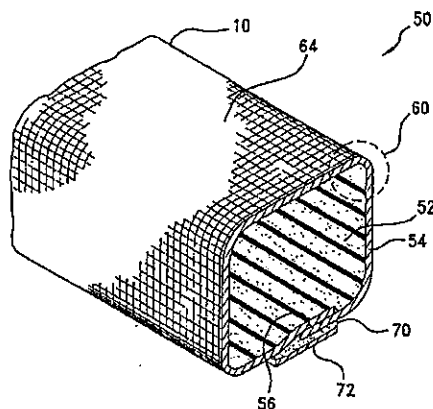
(52) **U.S. Cl.** 428/457; 361/818

(58) **Field of Search** 427/77; 361/818; 428/457

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,178,410 A	12/1979	Tomita
4,396,661 A	8/1983	George et al.
4,447,484 A	5/1984	Slosberg et al.
4,489,126 A	12/1984	Holtrop et al.



US 6,521,348 B2

Page 2

U.S. PATENT DOCUMENTS

4,666,765 A 5/1987 Caldwell et al.
 4,684,762 A 8/1987 Gladfeiter
 4,753,840 A 6/1988 Van Gompel
 4,797,171 A 1/1989 Van Gompel
 4,857,668 A 8/1989 Buonanno
 4,871,477 A 10/1989 Dimanshteyn
 4,988,550 A 1/1991 Keyser et al.
 5,009,927 A 4/1991 Cloyd et al.
 5,028,739 A 7/1991 Keyser et al.
 5,045,635 A 9/1991 Kaplo et al.
 5,089,325 A 2/1992 Covey
 5,105,056 A 4/1992 Hoge, Jr. et al.
 5,122,411 A 6/1992 Iwamoto et al.
 5,202,536 A 4/1993 Buonanno
 5,204,403 A 4/1993 Furuta et al.
 5,266,354 A 11/1993 Tohyama et al.

5,612,092 A 3/1997 Strenger et al.
 5,614,306 A 3/1997 Jobe et al.
 5,635,252 A 6/1997 Fraser, Jr. et al.
 5,641,544 A 6/1997 Melancon et al.
 5,674,606 A 10/1997 Powers, Jr.
 5,700,532 A 12/1997 Chiou
 2001/0028558 A1 * 10/2001 Rapp et al. 361/818

OTHER PUBLICATIONS

Chomerics Parker Hannifin Seals Catalog dated 1997 for
 Soft-Shield Low Closure Force EMI Gaskets.
 Monsanto Electron Metalized Materials dated Sep. 12, 1995.
 Copy of International Search Report for PCT Case No.
 PCT/US99/04100, Jan. 7, 1999.
 Underwriters Laboratories, Inc. letter dated Sep. 20, 1995.

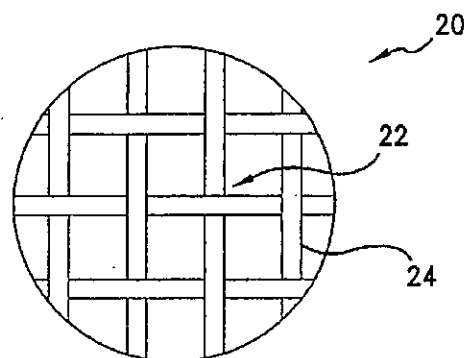
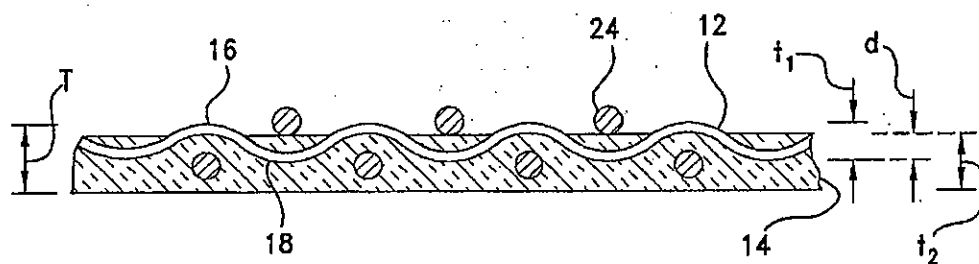
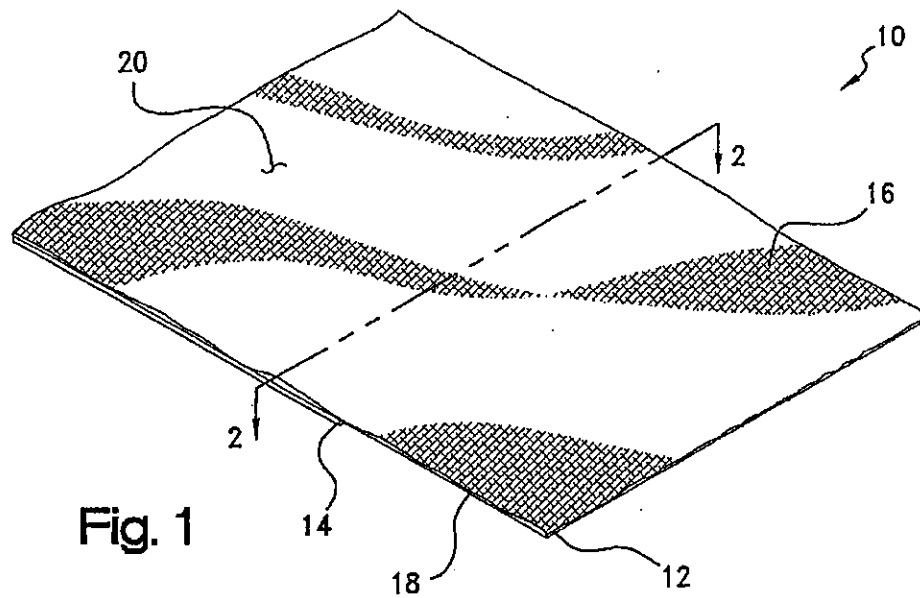
* cited by examiner

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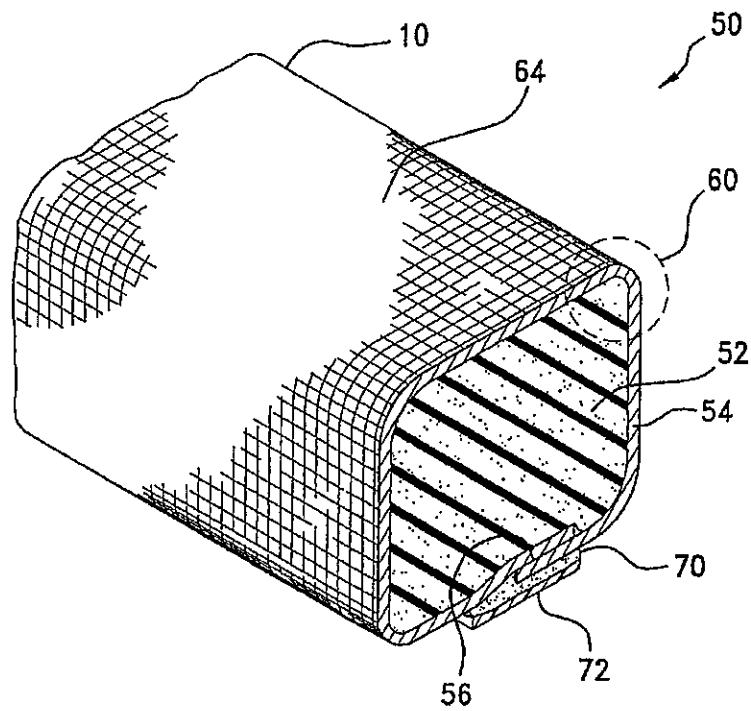


Fig. 4

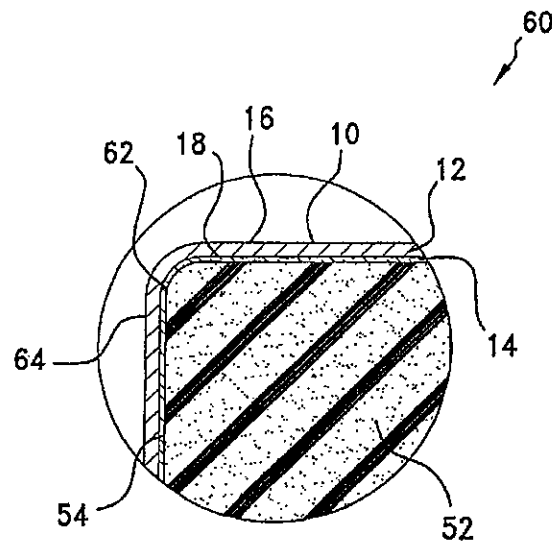
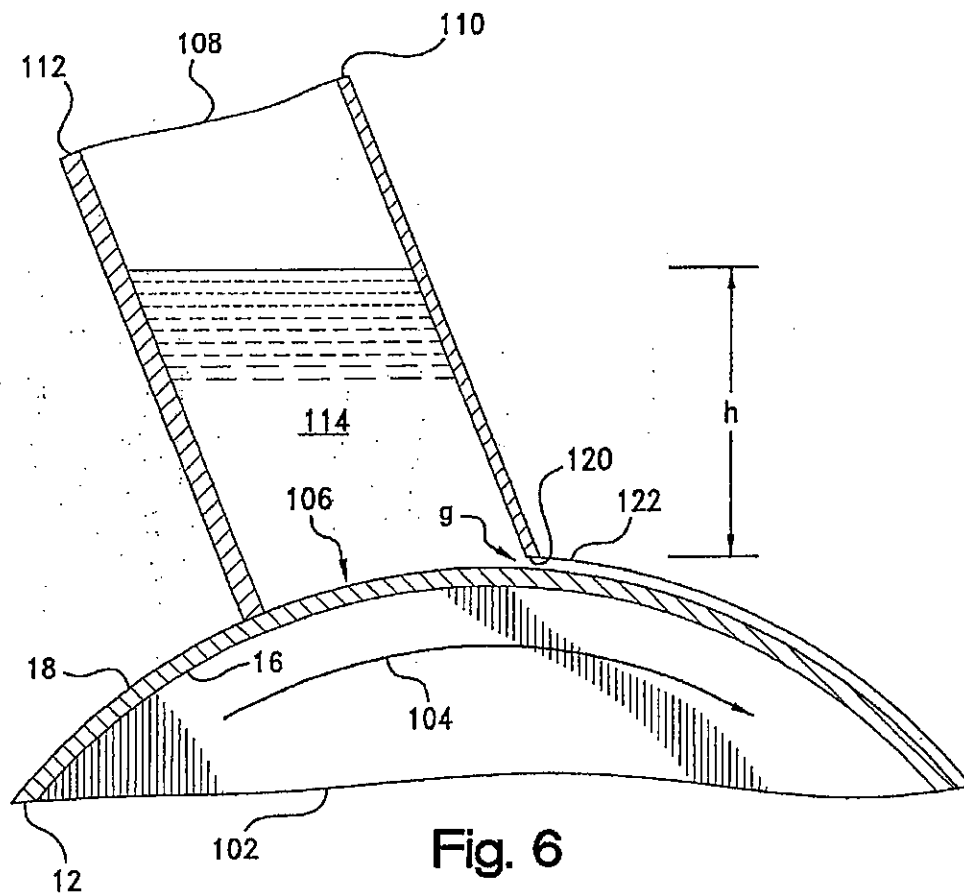


Fig. 5



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FLAME RETARDANT EMI SHIELDING GASKET

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 09/883,785, filed Jun. 18, 2001, which application is to issue as U.S. Pat. No. 6,387,523; which is a continuation of U.S. application Ser. No. 09/250,338, filed Feb. 16, 1999, now U.S. Pat. No. 6,428,393 and claiming priority to U.S. provisional application Serial No. 60/076,370, filed Feb. 27, 1998, the disclosure of each of which is expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates broadly to electrically-conductive, flame retardant materials for use in electromagnetic interference (EMI) shielding, and to a method of manufacturing the same, and more particularly to an electrically-conductive fabric having a layer of a flame retardant coating applied to one surface thereof for use as a sheathing within an EMI shielding gasket.

The operation of electronic devices including televisions, radios, computers, medical instruments, business machines, communications equipment, and the like is attended by the generation of electromagnetic radiation within the electronic circuitry of the equipment. Such radiation often develops as a field or as transients within the radio frequency band of the electromagnetic spectrum, i.e., between about 10 KHz and 10 GHz, and is termed "electromagnetic interference" or "EMI" as being known to interfere with the operation of other proximate electronic devices.

To attenuate EMI effects, shielding having the capability of absorbing and/or reflecting EMI energy may be employed both to confine the EMI energy within a source device, and to insulate that device or other "target" devices from other source devices. Such shielding is provided as a barrier which is inserted between the source and the other devices, and typically is configured as an electrically conductive and grounded housing which encloses the device. As the circuitry of the device generally must remain accessible for servicing or the like, most housings are provided with openable or removable accesses such as doors, hatches, panels, or covers. Between even the flattest of these accesses and its corresponding mating or faying surface, however, there may be present gaps which reduce the efficiency of the shielding by presenting openings through which radiant energy may leak or otherwise pass into or out of the device. Moreover, such gaps represent discontinuities in the surface and ground conductivity of the housing or other shielding, and may even generate a secondary source of EMI radiation by functioning as a form of slot antenna. In this regard, bulk or surface currents induced within the housing develop voltage gradients across any interface gaps in the shielding, which gaps thereby function as antennas which radiate EMI noise. In general, the amplitude of the noise is proportional to the gap length, with the width of the gap having a less appreciable effect.

For filling gaps within mating surfaces of housings and other EMI shielding structures, gaskets and other seals have been proposed both for maintaining electrical continuity across the structure, and for excluding from the interior of the device such contaminants as moisture and dust. Such seals are bonded or mechanically attached to, or press-fit into, one of the mating surfaces, and function to close any interface gaps to establish a continuous conductive path

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thereacross by conforming under an applied pressure to irregularities between the surfaces. Accordingly, seals intended for EMI shielding applications are specified to be of a construction which not only provides electrical surface conductivity even while under compression, but which also has a resiliency allowing the seals to conform to the size of the gap. The seals additionally must be wear resistant, economical to manufacture, and capability of withstanding repeated compression and relaxation cycles. For further information on specifications for EMI shielding gaskets, reference may be had to Severinsen, J., "Gaskets That Block EMI," *Machine Design*, Vol. 47, No. 19, pp. 74-77 (Aug. 7, 1975).

Requirements for typical EMI shielding applications often dictate a low impedance, low profile gasket which is deflectable under normal closure force loads. Other requirements include low cost and a design which provides an EMI shielding effectiveness for both the proper operation of the device and compliance, in the United States, with commercial Federal Communication Commission (FCC) EMC regulations.

A particularly economical gasket construction, which also requires very low closure forces, i.e. less than about 1 lb/inch (0.175 N/mm), is marketed by the Chomerics Division of Parker-Hannifin Corp., Woburn, Mass. under the tradename "Soft-Shield® 5000 Series." Such construction consists of an electrically-conductive jacket or sheathing which is "cigarette" wrapped lengthwise over a polyurethane or other foam core. As is described further in U.S. Pat. No. 4,871,477, polyurethane foams generally are produced by the reaction of polyisocyanate and a hydroxyl-functional polyol in the presence of a blowing agent. The blowing agent effects the expansion of the polymer structure into a multiplicity of open or closed cells.

The jacket is provided as a highly conductive, i.e., about 1 Ω -sq., nickel-plated-silver, woven rip-stop nylon which is self-terminating when cut. Advantageously, the jacket may be bonded to the core in a continuous molding process wherein the foam is blown or expanded within the jacket as the jacket is wrapped around the expanding foam and the foam and jacket are passed through a die and into a traveling molding. Similar gasket constructions are shown in commonly-assigned U.S. Pat. No. 5,028,739 and in U.S. Pat. Nos. 4,857,668; 5,054,635; 5,105,056; and 5,202,536.

Many electronic devices, including PC's and communication equipment, must not only comply with certain FCC requirements, but also must meet be approved under certain Underwriter's Laboratories (UL) standards for flame retardancy. In this regard, if each of the individual components within an electronic device is UL approved, then the device itself does not require separate approval. Ensuring UL approval for each component therefore reduces the cost of compliance for the manufacturer, and ultimately may result in cheaper goods for the consumer. For EMI shielding gaskets, however, such gaskets must be made flame retardant, i.e., achieving a rating of V-0 under UL Std. No. 94, "Tests for Flammability of Plastic Materials for Parts in Devices and Appliances" (1991), without compromising the electrical conductivity necessary for meeting EMI shielding requirements.

In this regard, and particularly with respect to EMI shielding gaskets of the above-described fabric over foam variety, it has long been recognized that foamed polymeric materials are flammable and, in certain circumstances, may present a fire hazard. Owing to their cellular structure, high organic content, and surface area, most foam materials are

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subject to relatively rapid decomposition upon exposure to fire or high temperatures.

One approach for imparting flame retardancy to fabric over foam gaskets has been to employ the sheathing as a flame resistant protective layer for the foam. Indeed, V-0 rating compliance purportedly has been achieved by sheathing the foam within an electrically-conductive Ni/Cu-plated fabric to which a thermoplastic sheet is hot nipped or otherwise fusion bonding to the underside thereof. Such fabrics, which may be further described in one or more of U.S. Pat. Nos. 4,489,126; 4,531,994; 4,608,104; and/or 4,621,013, have been marketed by Monsanto Co., St. Louis, under the tradename "Flectron® Ni/Cu Polyester Taffeta VO."

Other fabric over foam gaskets, as is detailed in U.S. Pat. No. 4,857,668, incorporate a supplemental layer or coating applied to the interior surface of the sheath. Such coating may be a flame-retardant urethane formulation which also promotes the adhesion of the sheath to the foam. The coating additionally may function to reduce bleeding of the foam through the fabric which otherwise could compromise the electrical conductivity of the sheath.

In view of the foregoing, it will be appreciated that further improvements in the design of flame retardant, fabric-over foam EMI shielding gaskets, as well as sheathing materials therefore, would be well-received by the electronics industry. Especially desired would be a flame retardant gasket construction which achieves a UL94 rating of V-0.

BROAD STATEMENT OF THE INVENTION

The present invention is directed to an electrically-conductive, flame retardant material for use in fabric-over-foam EMI shielding gaskets, and to a method of manufacturing the same. In having a layer of a flame retardant coating applied to one side of an electrically-conductive, generally porous fabric, the material of the invention affords UL94 V-0 protection when used as a jacketing in a fabric-over-foam gasket construction. Advantageously, as the flame retardant layer may be wet coated on the fabric without appreciable bleed through, a relatively thin, i.e., 2-4 mil (0.05-0.10 mm), coating layer may be provided on one fabric side without compromising the electrical surface conductivity of the other side. Such a thin coating layer, while being sufficient to provide UL94 V-0 protection, nonetheless maintains the drapability the fabric and thereby facilitates the construction UL94 V-0 compliant gaskets having complex profiles or narrow cross-sections down to about 1 mm.

In a preferred embodiment, the electrically-conductive, flame retardant EMI shielding material of the invention includes a nickel or silver-plated, woven nylon, polyester, or like fabric on one side of which is wet coated a layer of a flame retardant, acrylic latex emulsion or other fluent resin composition. In accordance with the precepts of the method of the invention, the viscosity and hydrodynamic pressure of the emulsion are controlled such that the coating does not penetrate or otherwise "bleed through" the uncoated side of the fabric. The surface conductivity of the opposite side of the fabric therefore is not compromised in EMI shielding applications.

The material of the invention may be employed as a jacket in fabric-over-foam EMI shielding gasket constructions, and is particularly adapted for use in the continuous molding process for such gaskets. As used within such process, the fabric may be wrapped around the foam as a jacket with coated side thereof being disposed as an interior surface

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adjacent the foam, and the uncoated side being disposed as an electrically-conductive exterior surface. Advantageously, the coating on the interior surface of the jacket blocks the pores of the fabric to retain the foam therein without penetrate or bleed through to the exterior surface. In being formed of a acrylic material, the coated interior surface of the jacket may function, moreover, depending upon the composition of the foam, as a compatibilizing or "tie" interlayer which promotes the bonding of the foam to the fabric.

The present invention, accordingly, comprises material and method possessing the construction, combination of elements, and arrangement of parts and steps which are exemplified in the detailed disclosure to follow. Advantages of the present invention include a flame retardant yet drapable EMI shielding fabric. Additional advantages include an economical, flame retardant EMI shielding fabric construction wherein a relatively thin layer of a flame retardant coating may be wet coated onto one side of an electrically-conductive, woven or other generally porous EMI shielding fabric without compromising the conductivity of the other side of the fabric. These and other advantages will be readily apparent to those skilled in the art based upon the disclosure contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of one embodiment of an EMI shielding material according to the present invention which material includes a generally planar fabric member on one side of which is coated a layer of a flame retardant composition, the view being shown with portions being broken away to better reveal the structure of the material;

FIG. 2 is an enlarged cross-sectional view of the EMI shielding material of FIG. 1 taken through plane represented by line 2-2 of FIG. 1;

FIG. 3 is a top view of the material of FIG. 1 which is magnified to reveal the structure of the fabric member thereof;

FIG. 4 is a perspective cross-sectional view of a length of a representative EMI shielding gasket construction according to the present invention including a jacket which is formed of the EMI shielding material of FIG. 1;

FIG. 5 is an end view of the gasket of FIG. 4 which is magnified to reveal the structure thereof; and

FIG. 6 is a schematic, partially cross-sectional view of an illustrative gravity-fed, knife over roll coater as adapted for use in the manufacture of the EMI shielding material of FIG. 1.

The drawings will be described further in connection with the following Detailed Description of the Invention.

DETAILED DESCRIPTION OF THE INVENTION

Certain terminology may be employed in the description to follow for convenience rather than for any limiting purpose. For example, the terms "upper" and "lower" designate directions in the drawings to which reference is made, with the terms "inner" or "interior" and "outer" or "exterior" referring, respectively, to directions toward and away from the center of the referenced element, and the terms "radial" and "axial" referring, respectively, to directions perpendicular

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lar and parallel to the longitudinal central axis of the referenced element. Terminology of similar import other than the words specifically mentioned above likewise is to be considered as being used for purposes of convenience rather than in any limiting sense.

For the illustrative purposes of the discourse to follow, the electromagnetic interference (EMI) shielding material herein involved is described in connection with its use as a flame retardant, electrically-conductive jacket for a foam core, EMI shielding gasket as may be adapted to be received within an interface, such as between a door, panel, hatch, cover, or other parting line of an electromagnetic interference (EMI) shielding structure. The EMI shielding structure may be the conductive housing of a computer, communications equipment, or other electronic device or equipment which generates EMI radiation or is susceptible to the effects thereof. The gasket may be bonded or fastened to, or press-fit into one of a pair of mating surfaces which define the interface within the housing, and functions between the mating surfaces to seal any interface gaps or other irregularities. That is, while under an applied pressure, the gasket resiliently conforms to any such irregularities both to establish a continuous conductive path across the interface, and to environmentally seal the interior of the housing against the ingress of dust, moisture, or other contaminants. It will be appreciated, however, that aspects of the present invention may find utility in other EMI shielding applications. Use within those such other applications therefore should be considered to be expressly within the scope of the present invention.

Referring then to the figures, wherein corresponding reference characters are used to designate corresponding elements throughout the several views, a flame retardant EMI shielding material according to the present invention is shown generally at 10 in FIG. 1 as generally adapted for use as a jacket within for a foam core gasket construction. For purposes of illustration, material sheet 10 is shown to be of indefinite dimensions which may be cut to size for the particular application envisioned. In basic construction, material 10 includes an upper, generally planar and porous fabric member, 12, and a lower, flame retardant coating member, 14.

Fabric member has at least an electrically-conductive first side, 16, and a conductive or non-conductive second side, 18, defining a thickness dimension, referenced at "t₁" in the cross-sectional view of FIG. 2, which may vary from about 2-4 mils (0.05-0.10 mm). By "electrically-conductive," it is meant that the fabric may be rendered conductive, i.e., to a surface resistivity of about 0.1 Ω /sq. or less, by reason of its being constructed of electrically-conductive wire, monofilaments, yarns or other fibers or, alternatively, by reason of a treatment such as a plating or sputtering being applied to non-conductive fibers to provide an electrically-conductive layer thereon. Preferred electrically-conductive fibers include Monel nickel-copper alloy, silver-plated copper, nickel-clad copper, Ferrex® tin-plated copper-clad steel, aluminum, tin-clad copper, phosphor bronze, carbon, graphite, and conductive polymers. Preferred non-conductive fibers include cotton, wool, silk, cellulose, polyester, polyamide, nylon, and polyimide monofilaments or yarns which are rendered electrically conductive with a metal plating of copper, nickel, silver, nickel-plated-silver, aluminum, tin, or an alloy thereof. As is known, the metal plating may be applied to individual fiber strands or to the surfaces of the fabric after weaving, knitting, or other fabrication.

While fabrics such as wire meshes, knits, and non-woven cloths and webs may find application, a preferred fabric

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construction for member 12 is a plain weave nylon or polyester cloth which is made electrically conductive with between about 20-40% by weight based on the total fabric weight, i.e., 0.01-0.10 g/in², of a silver, nickel-silver, or silver-nickel over copper plating. As may be seen in the magnified view of FIG. 1 referenced at 20 in FIG. 3, such cloth is permeable in having a plain, generally square weave pattern with pores or openings, one of which is referenced at 22, being defined between the fibers which are represented schematically at 24. Fibers 24 may be yarns, monofilaments or, preferably, bundles of from about 10-20 filaments or threads, each having a diameter of between about 10-50 gm. For example, with fibers 24 each being a bundle of such threads with a thread count of between about 1000-3000 per inch and a weave count of between about 1000-1500 per inch, 1000-2000 openings per inch will be defined with a mean average pore size of between about 0.5-2 mils (12.5-50 μ m).

Although a plain, square weave pattern such as a taffeta, tabby, or ripstop is considered preferred, other weaves such as satins, twills, and the like also should be considered within the scope of the invention herein involved. A particularly preferred cloth for fabric member 12 is a 4 mil (0.10 mm) thick, 1.8 oz/yd² weight, silver-plated, woven nylon which is marketed commercially under the designation "31EN RIPSTOP" by Swift Textile Metalizing Corp., Bloomfield, Conn. However, depending upon the needs of the specific shielding application, a fabric constructed of a combination or blend of conductive and nonconductive fibers alternatively may be employed. Examples of fabrics woven, braided, or warp knitted from electrically-conductive fibers, or from blends of conductive and non-conductive fibers, are described in Gladfelter, U.S. Pat. No. 4,684,762, and in Buonanno, U.S. Pat. No. 4,857,668.

Returning to FIGS. 1 and 2, coating member 14 preferably is formed from a curable layer of a fluent, flame retardant resin or other composition which is wet coated onto the second side 18 of fabric member 12. As is detailed hereinafter, the viscosity and hydrodynamic pressure of the resin composition are controlled in accordance with the precepts of the present invention to delimit the penetration of the resin layer to a depth, referenced at "d" in FIG. 2, which is less than the thickness dimension t₁ of the fabric member 12. In this regard, when the layer is cured to form the flame retardant surface coating member 14 on the second side 18 of fabric member 12, the first side 16 thereof remains electrically-conductive. In a preferred construction, the layer is coated to a wet thickness of about 10 mils (0.25 mm), and then cured to a dried coating or film thickness, referenced at t₂ in FIG. 2, of between about 2-4 mils (0.05-0.10 mm) at a depth d of about 1-2 mils (0.025-0.05 mm). Ultimately, a total material thickness, referenced at "T," of between about 6-7 mils (0.15-0.20 mm) and a dried weight pickup of between about 100-150 g/yd² are observed. By "cured" it is meant that the resin is polymerized, cross-linked, further cross-linked or polymerized, vulcanized, hardened, dried, volatilized, or otherwise chemically or physically changed from a liquid or other fluent form into a solid polymeric or elastomeric phase.

The flame retardant composition preferably is formulated as an aqueous emulsion of an acrylic latex emulsion which is adjusted to a total solids of about 60% and a Brookfield viscosity (#5 spindle, 4 speed) of between about 40,000-60,000 cps, at a density of about 10 lbs per gallon (1.8 g/cm³). Flame retardancy may be imparted by loading the emulsion with between about 30-50% by weight of one or more conventional flame retardant additives such as aluminum

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hydrate, antimony trioxide, phosphate esters, or halogenated compounds such as polybrominated diphenyl oxides. A preferred formulation is a mixture of about 25% by weight, based on the total weight of the emulsion, of decabromodiphenyl oxide and about 15% by weight of one or more antimony compounds. In operation, should the acrylic carrier phase be ignited, the decomposition of the halogenated and metal oxide compounds function to chemically deprive the flame of sufficient oxygen to support combustion. The decomposition of the acrylic phase additionally may lead to the development of a protective, i.e., thermally-insulative or refractory, outer char layer.

A preferred flame retardant, acrylic latex emulsion is marketed commercially by Heveatex Corp., Fall River, Mass., under the designation "4129FR." The viscosity of the emulsion may be adjusted to between about 40,000–60,000 cps using an aqueous acryloid gel or other acrylic thickener. In this regard, the increased viscosity of the emulsion contributes to delimiting the penetration of the coating layer into the fabric member. However, as this relatively high viscosity may lead to undesirable porosity in the dried film, the emulsion additionally may be modified to reduce air entrapment and bubble formation in the coating layer with up to about 1% by weight of one or more commercial surfactants such as "Bubble Breaker" by Witco Chemical Corp. (Chicago, Ill.) and "Foam Master Antifoam" by Diamond Shamrock, Inc. (San Antonio, Tex.).

As aforementioned, EMI shielding material 10 of the present invention is particularly adapted for use as a flame retardant, electrically-conductive jacket which is provided over a foam core in an EMI shielding gasket construction such as gasket 50 of FIG. 4. In a representative embodiment, gasket 50 includes an elongate, resilient foam core member, 52, which may be of an indefinite length. Core member 52 has an outer circumferential surface, 54, defining the cross-sectional profile of gasket 50 which, for illustrative purposes, is of a generally polygonal, i.e., square or rectangular geometry. Other plane profiles, such as circular, semi-circular, or elliptical, or complex profiles may be substituted, however, depending upon the geometry of the interface to be sealed. Core member 12 may be of any radial or diametric extent, but for most applications will have a diametric extent or width of from about 0.25 inch (0.64 cm) to 1 inch (2.54 cm).

For affording gap-filling capabilities, it is preferred that core member 52 is provided to be compliant over a wide range of temperatures, and to exhibit good compression-relaxation hysteresis even after repeated cyclings or long compressive dwells. Core member 52 therefore may be formed of a foamed elastomeric thermoplastic such as a polyethylene, polypropylene, polypropylene-EPDM blend, butadiene, styrene-butadiene, nitrile, chlorosulfonate, or a foamed neoprene, urethane, or silicone. Preferred materials of construction include open or closed cell urethanes or blends such as a polyolefin resin/monoolefin copolymer blend, or a neoprene, silicone, or nitrile sponge rubber.

Core member 52 may be provided as an extruded or molded foam profile over which shielding material 10 is wrapped as a sheathed, with the edges of sheathed being overlapped as at 56. In a preferred construction, shielding material 10 is bonded to the core member 52 in a continuous molding process wherein the foam is blown or expanded within the shielding material. As may be seen best with reference to the magnified view of FIG. 4 referenced at 60 in FIG. 5, in such construction coating member 14 is disposed adjacent core member 52 as an interior surface, 62, of shielding member 10, with the uncoated side 16 of fabric

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member 12 being oppositely disposed as an electrically-conductive exterior surface, 64, of the gasket 50. It will be appreciated that the coated interior surface 62 blocks the pores 22 (FIG. 3) of the fabric member 12 of the fabric to retain the blown foam therein without penetrate or bleed through to the exterior gasket surface 64. Depending upon the respective compositions of the foam and coatings, the interior surface 62 may function, moreover, as a compatibilizing or "tie" interlayer which promotes the bonding of the foam to the fabric. Gasket construction 50 advantageously provides a structure that may be used in very low closure force, i.e. less than about 1 lb/inch (0.175 N/mm), applications.

Referring again to FIG. 4, an adhesive layer, 70, may be applied along the lengthwise extent of gasket 50 to the underside of exterior surface 64 for the attachment of the gasket to a substrate. Such layer 70 preferably is formulated to be of a pressure sensitive adhesive (PSA) variety. As is described in U.S. Pat. No. 4,988,550, suitable PSA's for EMI shielding applications include formulations based on silicones, neoprene, styrene butadiene copolymers, acrylics, acrylates, polyvinyl ethers, polyvinyl acetate copolymers, polyisobutylenes, and mixtures, blends, and copolymers thereof. Acrylic-based formulations, however, generally are considered to be preferred for the EMI applications of the type herein involved. Although PSA's are preferred for adhesive layer 70, other adhesives such as epoxies and urethanes may be substituted and, accordingly, are to be considered within the scope of the present invention. Heat-fusible adhesives such as hot-melts and thermoplastic films additionally may find applicability.

Inasmuch as the bulk conductivity of gasket 50 is determined substantially through its surface contact with the substrate, an electrically-conductive PSA may be preferred to ensure optimal EMI shielding performance. Such adhesives conventionally are formulated as containing about 1–25% by weight of a conductive filler to yield a volume resistivity of from about 0.01–0.001 Ω -cm. The filler may be incorporated in the form of particles, fibers, flakes, microspheres, or microballoons, and may range in size of from about 1–100 microns. Typically filler materials include inherently conductive material such as metals, carbon, and graphite, or nonconductive materials such as plastic or glass having a plating of a conductive material such as a noble metal or the like. In this regard, the means by which the adhesive is rendered electrically conductive is not considered to be a critical aspect of the present invention, such that any means achieving the desired conductivity and adhesion are to be considered suitable.

For protecting the outer portion of adhesive layer 70 which is exposed on the exterior surface of the gasket, a release sheets, shown at 72, may be provided as removably attached to the exposed adhesive. As is common in the adhesive art, release sheet 72 may be provided as strip of a waxed, siliconized, or other coated paper or plastic sheet or the like having a relatively low surface energy so as to be removable without appreciable lifting of the adhesive from the exterior surface 64.

In the production of commercial quantities of the EMI shielding material 10 of the present invention, the viscosity adjusted and otherwise modified acrylic latex emulsion or other resin composition may be coated and cured on one side of the fabric member 12 by a direct wet process such as knife over roll or slot die. With whatever process is employed, the hydrodynamic pressure of the resin composition is controlled in accordance with the precepts of the present invention to delimit the penetration of the resin layer to a depth

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which is less than the thickness dimension of the fabric member. For example, and with reference to FIG. 6 wherein the head of a representative gravity-fed knife over roll coater is shown somewhat schematically at 100, porous, i.e., permeable, fabric member 12 is conveyed from a feed roll or the like (not shown) over a nip roller, 102, which rotates in the direction referenced by arrow 104. With the first side 16 of fabric member 12 supported on roller 102, the fabric second side 18 is passed beneath the opening, referenced at 106, of a coating trough, 108. Trough 108 is defined by a front plate, 110, a back plate, 112, and a pair of side plates (not shown).

The emulsion or other fluent resin composition, referenced at 114, is pumped or otherwise transported into trough 108 which is filled to a fluid level, referenced at h. For a given fluid density, this level h is controlled such that the hydrodynamic pressure at the fabric-liquid interface is maintained within preset limits. For example, with a fluid density of about 10 pounds per gallon (1.8 g/cm³), and a fabric having a porosity of about 1000-2000 openings per inch with a mean average pore size of between about 0.5-2 mils (12.5-50 μ m), the fluid level H is controlled at about 4 inches (10 cm) to yield a hydrodynamic pressure of about 0.05 psi (0.35 kPa) at the fabric-liquid interface. For other coating processes, the hydrodynamic fluid pressure may be controlled, for example, by a pumping pressure or the like.

In the illustrative knife-over-roll coating process, the lower edge, 120, of front plate 110 defines a knife surface which is shimmed or otherwise spaced-apart a predetermined distance from the second side 18 of fabric member 12. Such spacing provides a clearance or gap, referenced at "g," of typically about 10 mils (0.25 mm), but which is adjustable to regulate the thickness of the liquid coating layer, 122, being applied to the fabric member. From roller 104, the coated fabric member 12 may be conveyed via a take-up roller arrangement (not shown) through a in-line oven or the like to dry or flash the water or other diluent in the liquid coating layer 122, or to otherwise cure the liquid coating layer 122 in developing an adherent, tack-free, film or other layer of coating member 14 (FIG. 1) on the single side 18 of fabric member 12.

The Example to follow, wherein all percentages and proportions are by weight unless otherwise expressly indicated, is illustrative of the practicing of the invention herein involved, but should not be construed in any limiting sense.

EXAMPLE

Representative EMI shielding materials according to the present invention were constructed for characterization. In this regard, a master batch of a flame retardant coating composition was compounded using an acrylic latex emulsion (Heveatex "4129FR"). The viscosity of the emulsion was adjusted to a Brookfield viscosity (#4 spindle, 40 speed) of about 60,000 cps with about 5 wt % of an acryloid thickener (Acrysol™ GS, Monsanto Co., St. Louis, Mo.). The modified emulsion had a total solids content of about 60% by weight, a density of about 10 pounds per gallon (1.8 g/cm³), and a pH of between about 7.5 and 9.5.

The emulsion was applied using a knife over roll coater (JETZONE Model 7319, Wolverine Corp., Merrimac, Mass.) to one side of a silver-plated nylon fabric (Swift "31EN RIPSTOP") having a thickness of about 4 mils (0.1 mm). With the fluid level in the coating trough of the coater maintained at about 4 inch (10 cm), the emulsion was delivered to the surface of the cloth at a hydrodynamic

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pressure of about 0.05 psi (0.35 kPa). The coating knife was shimmed to a 10 mil (0.25 mm) gap above the fabric to yield a wet coating draw down thickness of about 10 mils. Following an oven curing at 100-125° C. for 5 minutes, a dried coating or film thickness of about 2.5 mils (0.635 mm) was obtained with a weight pickup of about 130-145 g/yd² and a total material thickness of between about 6-7 mils (0.15-0.18 mm). An inspection of the coated fabric cloth revealed a coating penetration depth of about 1-2 mils (0.02-0.05 mm) providing acceptable mechanical retention and/or adhesion of the coating onto the fabric surface. The opposite side of the fabric, however, was observed to be substantially coating free, and to retain a surface resistivity of about 0.1 Ω /sq for unaffected EMI shielding effectiveness.

Fabric samples similarly coated in the manner described were subjected to an in-house vertical flame test. No burning was observed at dried film thickness of 2, 3, or 4 mils (0.05, 0.08, 0.10 mm). Accordingly, a reasonable operating window of film thickness was suggested for production runs.

Samples also were provided, as jacketed over a polyurethane foam core in an EMI shielding gasket construction, for flame testing by Underwriters Laboratories, Inc., Melville, N.Y. A flame class rating of V-0 under UL94 was assigned at a minimum thickness of 1.0 mm. The gasket construction therefore was found to be compliant with the applicable UL requirements, and was approved to bear the "UL" certification mark.

The foregoing results confirm that the EMI shielding material of the present invention affords UL94 V-0 protection when used as a jacketing in a fabric-over-foam gasket construction. Unexpectedly, it was found that a relatively porous or permeable fabric may be wet coated on one side with a relatively thin, i.e., 2-4 mil (0.05-0.10 mm), coating layer of a flame retardant composition without compromising the electrical surface conductivity of the other side. Such a thin coating layer, while being sufficient to provide UL94 V-0 protection in a conventional fabric-over-foam gasket construction, nonetheless maintains the drapability the fabric and thereby facilitates the fabrication of UL94 V-0 compliant gaskets having complex profiles or narrow cross-sections down to about 1 mm.

As it is anticipated that certain changes may be made in the present invention without departing from the precepts herein involved, it is intended that all matter contained in the foregoing description shall be interpreted as illustrative and not in a limiting sense. All references cited herein are expressly incorporated by reference.

What is claimed is:

1. A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

a resilient core member which is not V-0 rated under Underwriter's Laboratories (UL) Standard No. 94 extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;

an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and

a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame

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retardant layer being effective to afford said gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94 and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

2. The gasket of claim 1 wherein said flame retardant layer has a thickness of between about 2-4 mils (0.05-0.10 mm).

3. The gasket of claim 1 wherein said flame retardant layer is formed as a cured film of a flame retardant acrylic latex emulsion.

4. The gasket of claim 1 wherein said fabric member is a metal-plated cloth.

5. The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.

6. The gasket of claim 1 wherein said foamed elastomeric material is selected from the group consisting of polyethylenes, polypropylenes, polypropylene-EPDM blends, butadienes, styrene-butadienes, nitriles, chlorosulfonates, neoprenes, urethanes, silicones, and polyolefin resin/monoolefin copolymer blends, and combinations thereof.

7. The gasket of claim 1 wherein said fabric member has a thickness of between about 2-4 mils (0.05-0.10 mm).

8. A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;

an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and

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a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprising between about 30-50% by weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

9. The gasket of claim 8 wherein said flame retardant layer has a thickness of between about 2-4 mils (0.05-0.10 mm).

10. The gasket of claim 8 wherein said flame retardant layer is formed as a cured film of a flame retardant acrylic latex emulsion.

11. The gasket of claim 8 wherein said fabric member is a metal-plated cloth.

12. The gasket of claim 11 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.

13. The gasket of claim 8 wherein said foamed elastomeric material is selected from the group consisting of polyethylenes, polypropylenes, polypropylene-EPDM blends, butadienes, styrene-butadienes, nitriles, chlorosulfonates, neoprenes, urethanes, silicones, and polyolefin resin/monoolefin copolymer blends, and combinations thereof.

14. The gasket of claim 8 wherein said fabric member has a thickness of between about 2-4 mils (0.05-0.10 mm).

15. The gasket of claim 8 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

16. The gasket of claim 15 wherein said core member is not V-0 rated under Underwriter's Laboratories (UL) Standard No. 94.

17. The gasket of claim 8 wherein said core member is not V-0 rated under Underwriter's Laboratories (UL) Standard No. 94.

18. The gasket of claim 8 wherein said one or more flame retardant additives are selected from the group consisting of aluminum hydrate, antimony trioxide, phosphate esters, and halogenated compounds.

* * * * *

EXHIBIT B



US006716536B2

(12) **United States Patent**
Bunyan et al.

(10) Patent No.: **US 6,716,536 B2**
(45) Date of Patent: ***Apr. 6, 2004**

(54) **FLAME RETARDANT EMI SHIELDING GASKET**

4,531,994 A 7/1985 Holtrop et al.
4,540,617 A 9/1985 Kawanishi et al.

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FOREIGN PATENT DOCUMENTS

DE	9013936	12/1990
FR	2308030	11/1976
JP	07-176889	* 7/1995
WO	0326441	8/1989

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

OTHER PUBLICATIONS

This patent is subject to a terminal disclaimer.

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(63) Continuation of application No. 10/142,803, filed on May 9, 2002, now Pat. No. 6,521,348, which is a continuation of application No. 09/883,785, filed on Jun. 18, 2001, now Pat. No. 6,387,523, which is a continuation of application No. 09/250,338, filed on Feb. 16, 1999, now Pat. No. 6,248,393.
(60) Provisional application No. 60/076,370, filed on Feb. 27, 1998.

(51) Int. Cl.⁷ **B32B 5/14; B32B 5/18; H05K 9/00**

(52) U.S. Cl. **428/457; 361/818**

(58) Field of Search **428/457; 361/818**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,178,410 A	12/1979	Tomita
4,396,661 A	8/1983	George et al.
4,447,484 A	5/1984	Slosberg et al.
4,489,126 A	12/1984	Holtrop et al.

Kleiner, J. Vinyl Technol. vol 4 No. 4, Dec. 1982, pp 157-159.*

Dye, James M. Compliance Engineering 17(3), pp 138 and 140-145, 2000.*

Copy of International Search Report for PCT Case No. PCT/US99/04100, Jan. 7, 1999.

Chomerics Parker Hannifin Seals Catalog dated 1997 for Soft-Shield Low Closure Force EMI Gaskets.

Monsanto Electron Metalized Materials dated Sep. 12, 1995.

Copy of the International Application Published Under the Patent Cooperation Treaty in International Patent Application No. PCT/US00/20609 (WO 01/10182) entitled: "Method and Apparatus for Manufacturing A Flame Retardant EMI Gasket" Feb. 2001.

Underwriters Laboratories, Inc. letter dated Sep. 20, 1995.

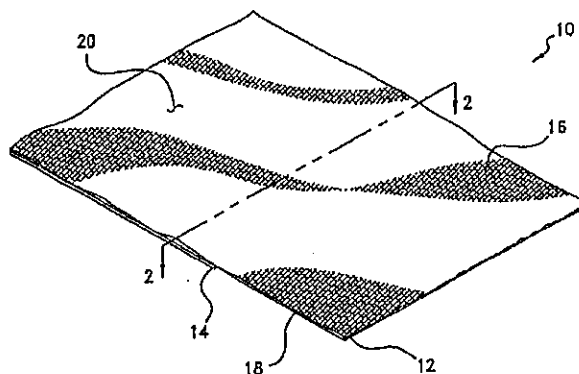
Primary Examiner—Erma Cameron

(74) *Attorney, Agent, or Firm*—John A. Molnar, Jr.

(57) **ABSTRACT**

A flame retardant, electromagnetic interference (EMI) shielding gasket construction. The construction includes a resilient core member formed of a foamed elastomeric material, an electrically-conductive fabric member surrounding the outer surface of the core member, and a flame retardant layer coating at least a portion of the interior surface of the fabric member. The flame retardant layer is effective to afford the gasket construction with a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

9 Claims, 3 Drawing Sheets



US 6,716,536 B2

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U.S. PATENT DOCUMENTS

4,569,304 A	2/1986	Le Maitre	5,089,325 A	2/1992	Covey
4,572,960 A	2/1986	Ebneth et al.	5,105,056 A	4/1992	Hoge, Jr. et al.
4,608,104 A	8/1986	Holtrop et al.	5,122,411 A	6/1992	Iwamoto et al.
4,621,013 A	11/1986	Holtrop et al.	5,202,536 A	4/1993	Buonanno
4,666,765 A	5/1987	Caldwell et al.	5,204,403 A	4/1993	Furuta et al.
4,684,762 A	8/1987	Gladfeiter	5,266,354 A	11/1993	Tohyama et al.
4,753,840 A	6/1988	Van Gompel	5,612,092 A	3/1997	Strenger et al.
4,797,171 A	1/1989	Van Gompel	5,614,306 A	3/1997	Jobe et al.
4,857,668 A	8/1989	Buonanno	5,635,252 A	6/1997	Fraser, Jr. et al.
4,871,477 A	10/1989	Dimansbteyn	5,641,438 A *	6/1997	Bunyan et al. 264/40.3
4,988,550 A	1/1991	Keyser et al.	5,641,544 A	6/1997	Melancon et al.
5,009,927 A	4/1991	Cloyd et al.	5,674,606 A	10/1997	Powers, Jr.
5,028,739 A	7/1991	Keyser et al.	5,700,532 A	12/1997	Chiou
5,045,635 A	9/1991	Kaplo et al.			

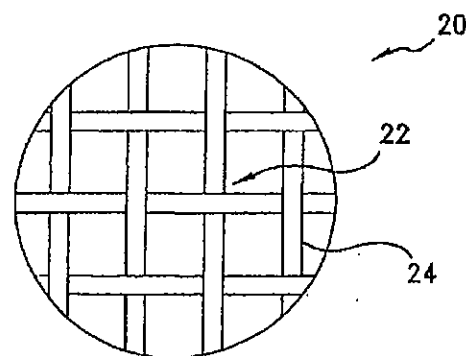
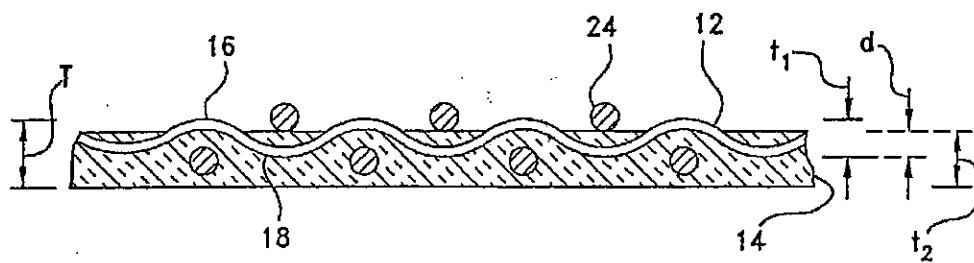
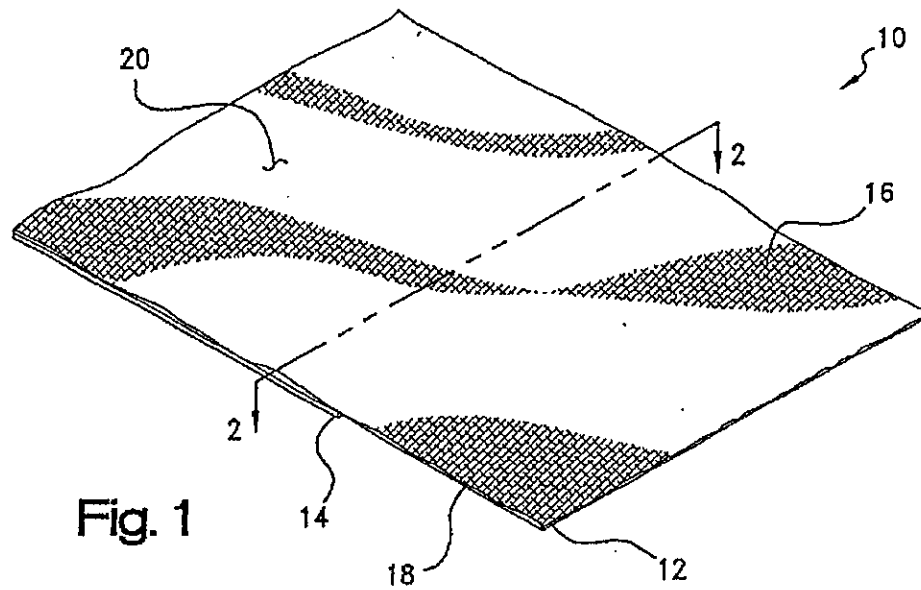
* cited by examiner

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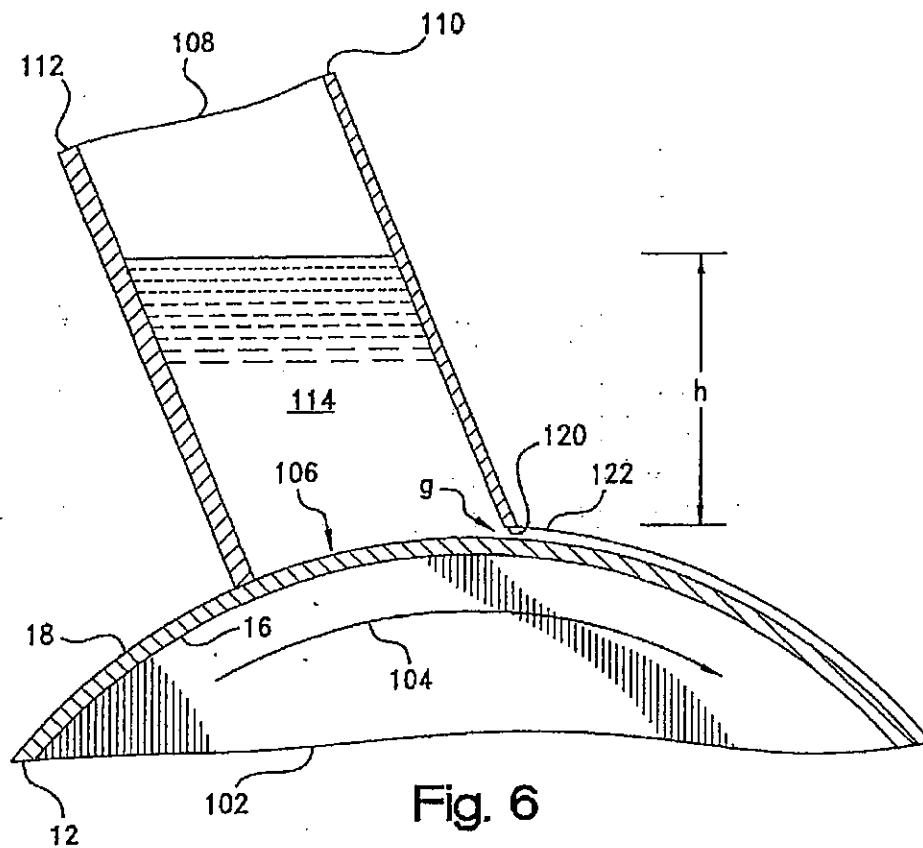


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FLAME RETARDANT EMI SHIELDING GASKET

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 10/142,803 filed May 9, 2002, now U.S. Pat. No. 6,521,348, which is a continuation of U.S. application Ser. No. 09/883,785, filed Jun. 18, 2001, now U.S. Pat. No. 6,387,523; which is a continuation of U.S. application Ser. No. 09/250,338, filed Feb. 16, 1999, now U.S. Pat. No. 6,248,393 and claiming priority to U.S. provisional application Ser. No. 60/076,370, filed Feb. 27, 1998, the disclosure of each of which is expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates broadly to electrically-conductive, flame retardant materials for use in electromagnetic interference (EMI) shielding, and to a method of manufacturing the same, and more particularly to an electrically-conductive fabric having a layer of a flame retardant coating applied to one surface thereof for use as a sheathing within an EMI shielding gasket.

The operation of electronic devices including televisions, radios, computers, medical instruments, business machines, communications equipment, and the like is attended by the generation of electromagnetic radiation within the electronic circuitry of the equipment. Such radiation often develops as a field or as transients within the radio frequency band of the electromagnetic spectrum, i.e., between about 10 KHz and 10 GHz, and is termed "electromagnetic interference" or "EMI" as being known to interfere with the operation of other proximate electronic devices.

To attenuate EMI effects, shielding having the capability of absorbing and/or reflecting EMI energy may be employed both to confine the EMI energy within a source device, and to insulate that device or other "target" devices from other source devices. Such shielding is provided as a barrier which is inserted between the source and the other devices, and typically is configured as an electrically conductive and grounded housing which encloses the device. As the circuitry of the device generally must remain accessible for servicing or the like, most housings are provided with openable or removable accesses such as doors, hatches, panels, or covers. Between even the flattest of these accesses and its corresponding mating or facing surface, however, there may be present gaps which reduce the efficiency of the shielding by presenting openings through which radiant energy may leak or otherwise pass into or out of the device. Moreover, such gaps represent discontinuities in the surface and ground conductivity of the housing or other shielding, and may even generate a secondary source of EMI radiation by functioning as a form of slot antenna. In this regard, bulk or surface currents induced within the housing develop voltage gradients across any interface gaps in the shielding, which gaps thereby function as antennas which radiate EMI noise. In general, the amplitude of the noise is proportional to the gap length, with the width of the gap having a less appreciable effect.

For filling gaps within mating surfaces of housings and other EMI shielding structures, gaskets and other seals have been proposed both for maintaining electrical continuity across the structure, and for excluding from the interior of the device such contaminants as moisture and dust. Such seals are bonded or mechanically attached to, or press-fit

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into, one of the mating surfaces, and function to close any interface gaps to establish a continuous conductive path thereacross by conforming under an applied pressure to irregularities between the surfaces. Accordingly, seals intended for EMI shielding applications are specified to be of a construction which not only provides electrical surface conductivity even while under compression, but which also has a resiliency allowing the seals to conform to the size of the gap. The seals additionally must be wear resistant, economical to manufacture, and capability of withstanding repeated compression and relaxation cycles. For further information on specifications for EMI shielding gaskets, reference may be had to Severinsen, J., "Gaskets That Block EMI," *Machine Design*, Vol. 47, No. 19, pp. 74-77 (Aug. 7, 1975).

Requirements for typical EMI shielding applications often dictate a low impedance, low profile gasket which is deflectable under normal closure force loads. Other requirements include low cost and a design which provides an EMI shielding effectiveness for both the proper operation of the device and compliance, in the United States, with commercial Federal Communication Commission (FCC) EMC regulations.

A particularly economical gasket construction, which also requires very low closure forces, i.e. less than about 1 lb/inch (0.175 N/mm), is marketed by the Chomerics Division of Parker-Hannifin Corp., Woburn, Mass. under the tradename "Soft-Shield® 5000 Series." Such construction consists of an electrically-conductive jacket or sheathing which is "cigarette" wrapped lengthwise over a polyurethane or other foam core. As is described further in U.S. Pat. No. 4,871,477, polyurethane foams generally are produced by the reaction of polyisocyanate and a hydroxyl-functional polyol in the presence of a blowing agent. The blowing agent effects the expansion of the polymer structure into a multiplicity of open or closed cells.

The jacket is provided as a highly conductive, i.e., about 1 Ω -sq., nickel-plated-silver, woven rip-stop nylon which is self-terminating when cut. Advantageously, the jacket may be bonded to the core in a continuous molding process wherein the foam is blown or expanded within the jacket as the jacket is wrapped around the expanding foam and the foam and jacket are passed through a die and into a traveling molding. Similar gasket constructions are shown in commonly-assigned U.S. Pat. No. 5,028,739 and in U.S. Pat. Nos. 4,857,668; 5,054,635; 5,105,056; and 5,202,536.

Many electronic devices, including PC's and communication equipment, must not only comply with certain FCC requirements, but also must meet be approved under certain Underwriter's Laboratories (UL) standards for flame retardancy. In this regard, if each of the individual components within an electronic device is UL approved, then the device itself does not require separate approval. Ensuring UL approval for each component therefore reduces the cost of compliance for the manufacturer, and ultimately may result in cheaper goods for the consumer. For EMI shielding gaskets, however, such gaskets must be made flame retardant, i.e., achieving a rating of V-0 under UL Std. No. 94, "Tests for Flammability of Plastic Materials for Parts in Devices and Appliances" (1991), without compromising the electrical conductivity necessary for meeting EMI shielding requirements.

In this regard, and particularly with respect to EMI shielding gaskets of the above-described fabric over foam variety, it has long been recognized that foamed polymeric materials are flammable and, in certain circumstances, may

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present a fire hazard. Owing to their cellular structure, high organic content, and surface area, most foam materials are subject to relatively rapid decomposition upon exposure to fire or high temperatures.

One approach for imparting flame retardancy to fabric over foam gaskets has been to employ the sheathing as a flame resistant protective layer for the foam. Indeed, V-0 rating compliance purportedly has been achieved by sheathing the foam within an electrically-conductive Ni/Cu-plated fabric to which a thermoplastic sheet is hot nipped or otherwise fusion bonding to the underside thereof. Such fabrics, which may be further described in one or more of U.S. Pat. Nos. 4,489,126; 4,531,994; 4,608,104; and/or 4,621,013, have been marketed by Monsanto Co., St. Louis, under the tradename "Flectron® Ni/Cu Polyester Taffeta V0."

Other fabric over foam gaskets, as is detailed in U.S. Pat. No. 4,857,668, incorporate a supplemental layer or coating applied to the interior surface of the sheath. Such coating may be a flame-retardant urethane formulation which also promotes the adhesion of the sheath to the foam. The coating additionally may function to reduce bleeding of the foam through the fabric which otherwise could compromise the electrical conductivity of the sheath.

In view of the foregoing, it will be appreciated that further improvements in the design of flame retardant, fabric-over foam EMI shielding gaskets, as well as sheathing materials therefore, would be well-received by the electronics industry. Especially desired would be a flame retardant gasket construction which achieves a UL94 rating of V-0.

BROAD STATEMENT OF THE INVENTION

The present invention is directed to an electrically-conductive, flame retardant material for use in fabric-over-foam EMI shielding gaskets; and to a method of manufacturing the same. In having a layer of a flame retardant coating applied to one side of an electrically-conductive, generally porous fabric, the material of the invention affords UL94 V-0 protection when used as a jacketing in a fabric-over-foam gasket construction. Advantageously, as the flame retardant layer may be wet coated on the fabric without appreciable bleed through, a relatively thin, i.e., 2-4 mil (0.05-0.10 mm), coating layer may be provided on one fabric side without compromising the electrical surface conductivity of the other side. Such a thin coating layer, while being sufficient to provide UL94 V-0 protection, nonetheless maintains the drapability the fabric and thereby facilitates the construction UL94 V-0 compliant gaskets having complex profiles or narrow cross-sections down to about 1 mm.

In a preferred embodiment, the electrically-conductive, flame retardant EMI shielding material of the invention includes a nickel or silver-plated, woven nylon, polyester, or like fabric on one side of which is wet coated a layer of a flame retardant, acrylic latex emulsion or other fluent resin composition. In accordance with the precepts of the method of the invention, the viscosity and hydrodynamic pressure of the emulsion are controlled such that the coating does not penetrate or otherwise "bleed through" the uncoated side of the fabric. The surface conductivity of the opposite side of the fabric therefore is not compromised in EMI shielding applications.

The material of the invention may be employed as a jacket in fabric-over-foam EMI shielding gasket constructions, and is particularly adapted for use in the continuous molding process for such gaskets. As used within such process, the

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fabric may be wrapped around the foam as a jacket with coated side thereof being disposed as an interior surface adjacent the foam, and the uncoated side being disposed as an electrically-conductive exterior surface. Advantageously, the coating on the interior surface of the jacket blocks the pores of the fabric to retain the foam therein without penetrate or bleed through to the exterior surface. In being formed of a acrylic material, the coated interior surface of the jacket may function, moreover, depending upon the composition of the foam, as a compatibilizing or "tie" interlayer which promotes the bonding of the foam to the fabric.

The present invention, accordingly, comprises material and method possessing the construction, combination of elements, and arrangement of parts and steps which are exemplified in the detailed disclosure to follow. Advantages of the present invention include a flame retardant yet drapable EMI shielding fabric. Additional advantages include an economical, flame retardant EMI shielding fabric construction wherein a relatively thin layer of a flame retardant coating may be wet coated onto one side of an electrically-conductive, woven or other generally porous EMI shielding fabric without compromising the conductivity of the other side of the fabric. These and other advantages will be readily apparent to those skilled in the art based upon the disclosure contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of one embodiment of an EMI shielding material according to the present invention which material includes a generally planar fabric member on one side of which is coated a layer of a flame retardant composition, the view being shown with portions being broken away to better reveal the structure of the material;

FIG. 2 is an enlarged cross-sectional view of the EMI shielding material of FIG. 1 taken through plane represented by line 2-2 of FIG. 1;

FIG. 3 is a top view of the material of FIG. 1 which is magnified to reveal the structure of the fabric member thereof;

FIG. 4 is a perspective cross-sectional view of a length of a representative EMI shielding gasket construction according to the present invention including a jacket which is formed of the EMI shielding material of FIG. 1;

FIG. 5 is an end view of the gasket of FIG. 4 which is magnified to reveal the structure thereof, and

FIG. 6 is a schematic, partially cross-sectional view of an illustrative gravity-fed, knife over roll coater as adapted for use in the manufacture of the EMI shielding material of FIG. 1.

The drawings will be described further in connection with the following Detailed Description of the Invention.

DETAILED DESCRIPTION OF THE INVENTION

Certain terminology may be employed in the description to follow for convenience rather than for any limiting purpose. For example, the terms "upper" and "lower" designate directions in the drawings to which reference is made, with the terms "inner" or "interior" and "outer" or "exterior" referring, respectively, to directions toward and away from

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the center of the referenced element, and the terms "radial" and "axial" referring, respectively, to directions perpendicular and parallel to the longitudinal central axis of the referenced element. Terminology of similar import other than the words specifically mentioned above likewise is to be considered as being used for purposes of convenience rather than in any limiting sense.

For the illustrative purposes of the discourse to follow, the electromagnetic interference (EMI) shielding material herein involved is described in connection with its use as a flame retardant, electrically-conductive jacket for a foam core, EMI shielding gasket as may be adapted to be received within an interface, such as between a door, panel, hatch, cover, or other parting line of an electromagnetic interference (EMI) shielding structure. The EMI shielding structure may be the conductive housing of a computer, communications equipment, or other electronic device or equipment which generates EMI radiation or is susceptible to the effects thereof. The gasket may be bonded or fastened to, or press-fit into one of a pair of mating surfaces which define the interface within the housing, and functions between the mating surfaces to seal any interface gaps or other irregularities. That is, while under an applied pressure, the gasket resiliently conforms to any such irregularities both to establish a continuous conductive path across the interface, and to environmentally seal the interior of the housing against the ingress of dust, moisture, or other contaminants. It will be appreciated, however, that aspects of the present invention may find utility in other EMI shielding applications. Use within those such other applications therefore should be considered to be expressly within the scope of the present invention.

Referring then to the figures, wherein corresponding reference characters are used to designate corresponding elements throughout the several views, a flame retardant EMI shielding material according to the present invention is shown generally at 10 in FIG. 1 as generally adapted for use as a jacket within for a foam core gasket construction. For purposes of illustration, material sheet 10 is shown to be of indefinite dimensions which may be cut to size for the particular application envisioned. In basic construction, material 10 includes an upper, generally planar and porous fabric member, 12, and a lower, flame retardant coating member, 14.

Fabric member has at least an electrically-conductive first side, 16, and a conductive or non-conductive second side, 18, defining a thickness dimension, referenced at "t," in the cross-sectional view of FIG. 2, which may vary from about 2-4 mils (0.05-0.10 mm). By "electrically-conductive," it is meant that the fabric may be rendered conductive, i.e., to a surface resistivity of about 0.1 Ω /sq. or less, by reason of its being constructed of electrically-conductive wire, monofilaments, yarns or other fibers or, alternatively, by reason of a treatment such as a plating or sputtering being applied to non-conductive fibers to provide an electrically-conductive layer thereon. Preferred electrically-conductive fibers include Monel nickel-copper alloy, silver-plated copper, nickel-clad copper, Ferrex® tin-plated copper-clad steel, aluminum, tin-clad copper, phosphor bronze, carbon, graphite, and conductive polymers. Preferred non-conductive fibers include cotton, wool, silk, cellulose, polyester, polyamide, nylon, and polyimide monofilaments or yarns which are rendered electrically conductive with a metal plating of copper, nickel, silver, nickel-plated-silver, aluminum, tin, or an alloy thereof. As is known, the metal plating may applied to individual fiber strands or to the surfaces of the fabric after weaving, knitting, or other fabrication.

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While fabrics such as wire meshes, knits, and non-woven cloths and webs may find application, a preferred fabric construction for member 12 is a plain weave nylon or polyester cloth which is made electrically conductive with between about 20-40% by weight based on the total fabric weight, i.e., 0.01-0.10 g/in², of a silver, nickel-silver, or silver-nickel over copper plating. As may be seen in the magnified view of FIG. 1 referenced at 20 in FIG. 3, such cloth is permeable in having a plain, generally square weave pattern with pores or openings, one of which is referenced at 22, being defined between the fibers which are represented schematically at 24. Fibers 24 may be yarns, monofilaments or, preferably, bundles of from about 10-20 filaments or threads, each having a diameter of between about 10-50 μ m. For example, with fibers 24 each being a bundle of such threads with a thread count of between about 1000-3000 per inch and a weave count of between about 1000-1500 per inch, 1000-2000 openings per inch will be defined with a mean average pore size of between about 0.5-2 mils (12.5-50 μ m).

Although a plain, square weave pattern such as a taffeta, tabby, or ripstop is considered preferred, other weaves such as satins, twills, and the like also should be considered within the scope of the invention herein involved. A particularly preferred cloth for fabric member 12 is a 4 mil (0.10 mm) thick, 1.8 oz/yd² weight, silver-plated, woven nylon which is marketed commercially under the designation "31EN RIPSTOP" by Swift Textile Metalizing Corp., Bloomfield, Conn. However, depending upon the needs of the specific shielding application, a fabric constructed of a combination or blend of conductive and nonconductive fibers alternatively may be employed. Examples of fabrics woven, braided, or warp knitted from electrically-conductive fibers, or from blends of conductive and non-conductive fibers, are described in Gladfelter, U.S. Pat. No. 4,684,762, and in Buonanno, U.S. Pat. No. 4,857,668.

Returning to FIGS. 1 and 2, coating member 14 preferably is formed from a curable layer of a fluent, flame retardant resin or other composition which is wet coated onto the second side 18 of fabric member 12. As is detailed hereinafter, the viscosity and hydrodynamic pressure of the resin composition are controlled in accordance with the precepts of the present invention to delimit the penetration of the resin layer to a depth, referenced at "d" in FIG. 2, which is less than the thickness dimension t_1 of the fabric member 12. In this regard, when the layer is cured to form the flame retardant surface coating member 14 on the second side 18 of fabric member 12, the first side 16 thereof remains electrically-conductive. In a preferred construction, the layer is coated to a wet thickness of about 10 mils (0.25 mm), and then cured to a dried coating or film thickness, referenced at t_2 in FIG. 2, of between about 2-4 mils (0.05-0.10 mm) at a depth d of about 1-2 mils (0.025-0.05 mm). Ultimately, a total material thickness, referenced at "T," of between about 6-7 mils (0.15-0.20 mm) and a dried weight pickup of between about 100-150 g/yd² are observed. By "cured" it is meant that the resin is polymerized, cross-linked, further cross-linked or polymerized, vulcanized, hardened, dried, volatilized, or otherwise chemically or physically changed from a liquid or other fluent form into a solid polymeric or elastomeric phase.

The flame retardant composition preferably is formulated as an aqueous emulsion of an acrylic latex emulsion which is adjusted to a total solids of about 60% and a Brookfield viscosity (#5 spindle, 4 speed) of between about 40,000-60,000 cps, at a density of about 10 lbs per gallon (1.8 g/cm³). Flame retardancy may be imparted by loading the emulsion

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with between about 30–50% by weight of one or more conventional flame retardant additives such as aluminum hydrate, antimony trioxide, phosphate esters, or halogenated compounds such as polybrominated diphenyl oxides. A preferred formulation is a mixture of about 25% by weight, based on the total weight of the emulsion, of decabromodiphenyl oxide and about 15% by weight of one or more antimony compounds. In operation, should the acrylic carrier phase be ignited, the decomposition of the halogenated and metal oxide compounds function to chemically deprive the flame of sufficient oxygen to support combustion. The decomposition of the acrylic phase additionally may lead to the development of a protective, i.e., thermally-insulative or refractory, outer char layer.

A preferred flame retardant, acrylic latex emulsion is marketed commercially by Heveatex Corp., Fall River, Mass., under the designation "4129FR." The viscosity of the emulsion may be adjusted to between about 40,000–60,000 cps using an aqueous acryloid gel or other acrylic thickener. In this regard, the increased viscosity of the emulsion contributes to delimiting the penetration of the coating layer into the fabric member. However, as this relatively high viscosity may lead to undesirable porosity in the dried film, the emulsion additionally may be modified to reduce air entrapment and bubble formation in the coating layer with up to about 1% by weight of one or more commercial surfactants such as "Bubble Breaker" by Witco Chemical Corp. (Chicago, Ill.) and "Foam Master Antifoam" by Diamond Shamrock, Inc. (San Antonio, Tex.).

As aforementioned, EMI shielding material 10 of the present invention is particularly adapted for use as a flame retardant, electrically-conductive jacket which is provided over a foam core in an EMI shielding gasket construction such as gasket 50 of FIG. 4. In a representative embodiment, gasket 50 includes an elongate, resilient foam core member, 52, which may be of an indefinite length. Core member 52 has an outer circumferential surface, 54, defining the cross-sectional profile of gasket 50 which, for illustrative purposes, is of a generally polygonal, i.e., square or rectangular geometry. Other plane profiles, such as circular, semi-circular, or elliptical, or complex profiles may be substituted, however, depending upon the geometry of the interface to be sealed. Core member 12 may be of any radial or diametric extent, but for most applications will have a diametric extent or width of from about 0.25 inch (0.64 cm) to 1 inch (2.54 cm).

For affording gap-filling capabilities, it is preferred that core member 52 is provided to be compliant over a wide range of temperatures, and to exhibit good compression-relaxation hysteresis even after repeated cyclings or long compressive dwells. Core member 52 therefore may be formed of a foamed elastomeric thermoplastic such as a polyethylene, polypropylene, polypropylene-EPDM blend, butadiene, styrene-butadiene, nitrile, chlorosulfonate, or a foamed neoprene, urethane, or silicone. Preferred materials of construction include open or closed cell urethanes or blends such as a polyolefin resin/monoolefin copolymer blend, or a neoprene, silicone, or nitrile sponge rubber.

Core member 52 may be provided as an extruded or molded foam profile over which shielding material 10 is wrapped as a sheath, with the edges of sheath being overlapped as at 56. In a preferred construction, shielding material 10 is bonded to the core member 52 in a continuous molding process wherein the foam is blown or expanded within the shielding material. As may be seen best with reference to the magnified view of FIG. 4 referenced at 60 in FIG. 5, in such construction coating member 14 is

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disposed adjacent core member 52 as an interior surface, 62, of shielding member 10, with the uncoated side 16 of fabric member 12 being oppositely disposed as an electrically-conductive exterior surface, 64, of the gasket 50. It will be appreciated that the coated interior surface 62 blocks the pores 22 (FIG. 3) of the fabric member 12 of the fabric to retain the blown foam therein without penetrate or bleed through to the exterior gasket surface 64. Depending upon the respective compositions of the foam and coating, the interior surface 62 may function, moreover, as a compatibilizing or "tie" interlayer which promotes the bonding of the foam to the fabric. Gasket construction 50 advantageously provides a structure that may be used in very low closure force, i.e. less than about 1 lb/inch (0.175 N/mm), applications.

Referring again to FIG. 4, an adhesive layer, 70, may be applied along the lengthwise extent of gasket 50 to the underside of exterior surface 64 for the attachment of the gasket to a substrate. Such layer 70 preferably is formulated to be of a pressure sensitive adhesive (PSA) variety. As is described in U.S. Pat. No. 4,988,550, suitable PSA's for EMI shielding applications include formulations based on silicones, neoprene, styrene butadiene copolymers, acrylics, acrylates, polyvinyl ethers, polyvinyl acetate copolymers, polyisobutylenes, and mixtures, blends, and copolymers thereof. Acrylic-based formulations, however, generally are considered to be preferred for the EMI applications of the type herein involved. Although PSA's are preferred for adhesive layer 70, other adhesives such as epoxies and urethanes may be substituted and, accordingly, are to be considered within the scope of the present invention. Heat-fusible adhesives such as hot-melts and thermoplastic films additionally may find applicability.

Inasmuch as the bulk conductivity of gasket 50 is determined substantially through its surface contact with the substrate, an electrically-conductive PSA may be preferred to ensure optimal EMI shielding performance. Such adhesives conventionally are formulated as containing about 1–25% by weight of a conductive filler to yield a volume resistivity of from about 0.01–0.001 Ω -cm. The filler may be incorporated in the form of particles, fibers, flakes, microspheres, or microballoons, and may range in size of from about 1–100 microns. Typically filler materials include inherently conductive material such as metals, carbon, and graphite, or nonconductive materials such as plastic or glass having a plating of a conductive material such as a noble metal or the like. In this regard, the means by which the adhesive is rendered electrically conductive is not considered to be a critical aspect of the present invention, such that any means achieving the desired conductivity and adhesion are to be considered suitable.

For protecting the outer portion of adhesive layer 70 which is exposed on the exterior surface of the gasket, a release sheet, shown at 72, may be provided as removably attached to the exposed adhesive. As is common in the adhesive art, release sheet 72 may be provided as strip of a waxed, siliconized, or other coated paper or plastic sheet or the like having a relatively low surface energy so as to be removable without appreciable lifting of the adhesive from the exterior surface 64.

In the production of commercial quantities of the EMI shielding material 10 of the present invention, the viscosity adjusted and otherwise modified acrylic latex emulsion or other resin composition may be coated and cured on one side of the fabric member 12 by a direct wet process such as knife over roll or slot die. With whatever process is employed, the hydrodynamic pressure of the resin composition is a con-

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trolled in accordance with the precepts of the present invention to delimit the penetration of the resin layer to a depth which is less than the thickness dimension of the fabric member. For example, and with reference to FIG. 6 wherein the head of a representative gravity-fed knife over roll coater is shown somewhat schematically at 100, porous, i.e., permeable, fabric member 12 is conveyed from a feed roll or the like (not shown) over a nip roller, 102, which rotates in the direction referenced by arrow 104. With the first side 16 of fabric member 12 supported on roller 102, the fabric second side 18 is passed beneath the opening, referenced at 106, of a coating trough, 108. Trough 108 is defined by a front plate, 110, a back plate, 112, and a pair of side plates (not shown).

The emulsion or other fluent resin composition, referenced at 114, is pumped or otherwise transported into trough 108 which is filled to a fluid level, referenced at h. For a given fluid density, this level h is controlled such that the hydrodynamic pressure at the fabric-liquid interface is maintained within preset limits. For example, with a fluid density of about 10 pounds per gallon (1.8 g/cm³), and a fabric having a porosity of about 1000–2000 openings per inch with a mean average pore size of between about 0.5–2 mils (12.5–50 μ m), the fluid level H is controlled at about 4 inches (10 cm) to yield a hydrodynamic pressure of about 0.05 psi (0.35 kPa) at the fabric-liquid interface. For other coating processes, the hydrodynamic fluid pressure may be controlled, for example, by a pumping pressure or the like.

In the illustrative knife-over-roll coating process, the lower edge, 120, of front plate 110 defines a knife surface which is shimmed or otherwise spaced-apart a predetermined distance from the second side 18 of fabric member 12. Such spacing provides a clearance or gap, referenced at "g," of typically about 10 mils (0.25 mm), but which is adjustable to regulate the thickness of the liquid coating layer, 122, being applied to the fabric member. From roller 104, the coated fabric member 12 may be conveyed via a take-up roller arrangement (not shown) through a in-line oven or the like to dry or flash the water or other diluent in the liquid coating layer 122, or to otherwise cure the liquid coating layer 122 in developing an adherent, tack-free, film or other layer of coating member 14 (FIG. 1) on the single side 18 of fabric member 12.

The Example to follow, wherein all percentages and proportions are by weight unless otherwise expressly indicated, is illustrative of the practicing of the invention herein involved, but should not be construed in any limiting sense.

EXAMPLE

Representative EMI shielding materials according to the present invention were constructed for characterization. In this regard, a master batch of a flame retardant coating composition was compounded using an acrylic latex emulsion (Heveatex "4129FR"). The viscosity of the emulsion was adjusted to a Brookfield viscosity (#4 spindle, 40 speed) of about 60,000 cps with about 5 wt % of an acryloid thickener (Acrysol™ GS, Monsanto Co., St. Louis, Mo.). The modified emulsion had a total solids content of about 60% by weight, a density of about 10 pounds per gallon (1.8 g/cm³), and a pH of between about 7.5 and 9.5.

The emulsion was applied using a knife over roll coater (JETZONE Model 7319, Wolverine Corp., Merrimac, Mass.) to one side of a silver-plated nylon fabric (Swift "31EN RIPSTOP") having a thickness of about 4 mils (0.1 mm). With the fluid level in the coating trough of the coater

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maintained at about 4 inch (10 cm), the emulsion was delivered to the surface of the cloth at a hydrodynamic pressure of about 0.05 psi (0.35 kPa). The coating knife was shimmed to a 10 mil (0.25 mm) gap above the fabric to yield a wet coating draw down thickness of about 10 mils. Following an oven curing at 100–125° C. for 5 minutes, a dried coating or film thickness of about 2.5 mils (0.635 mm) was obtained with a weight pickup of about 130–145 g/yd² and a total material thickness of between about 6–7 mils (0.15–0.18 mm). An inspection of the coated fabric cloth revealed a coating penetration depth of about 1–2 mils (0.02–0.05 mm) providing acceptable mechanical retention and/or adhesion of the coating onto the fabric surface. The opposite side of the fabric, however, was observed to be substantially coating free, and to retain a surface resistivity of about 0.1 Ω /sq for unaffected EMI shielding effectiveness.

Fabric samples similarly coated in the manner described were subjected to an in-house vertical flame test. No burning was observed at dried film thickness of 2, 3, or 4 mils (0.05, 0.08, 0.10 mm). Accordingly, a reasonable operating window of film thickness was suggested for production runs.

Samples also were provided, as jacketed over a polyurethane foam core in an EMI shielding gasket construction, for flame testing by Underwriters Laboratories, Inc., Melville, N.Y. A flame class rating of V-0 under UL94 was assigned at a minimum thickness of 1.0 mm. The gasket construction therefore was found to be compliant with the applicable UL requirements, and was approved to bear the "UL" certification mark.

The foregoing results confirm that, the EMI shielding material of the present invention affords UL94 V-0 protection when used as a jacketing in a fabric-over-foam gasket construction. Unexpectedly, it was found that a relatively porous or permeable fabric may be wet coated on one side with a relatively thin, i.e., 2–4 mil (0.05–0.10 mm), coating layer of a flame retardant composition without compromising the electrical surface conductivity of the other side. Such a thin coating layer, while being sufficient to provide UL94 V-0 protection in a conventional fabric-over-foam gasket construction, nonetheless maintains the drapability the fabric and thereby facilitates the fabrication of UL94 V-0 compliant gaskets having complex profiles or narrow cross-sections down to about 1 mm.

As it is anticipated that certain changes may be made in the present invention without departing from the precepts herein involved, it is intended that all matter contained in the foregoing description shall be interpreted as illustrative and not in a limiting sense. All references cited herein are expressly incorporated by reference.

What is claimed is:

1. A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

- a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;
- an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and

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a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprising at least about 30% by weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

2. The gasket of claim 1 wherein said flame retardant layer has a thickness of between about 2–4 mils (0.05–0.10 mm). 10

3. The gasket of claim 1 wherein said flame retardant layer is formed as a cured film of a flame retardant acrylic latex emulsion.

4. The gasket of claim 1 wherein said fabric member is a metal-plated cloth.

5. The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group

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consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.

6. The gasket of claim 1 wherein said foamed elastomeric material is selected from the group consisting of polyethylenes, polypropylenes, polypropylene-EPDM blends, butadienes, styrene-butadienes, nitriles, chlorosulfonates, neoprenes, urethanes, silicones, and polyolefin resin/monoolefin copolymer blends, and combinations thereof.

7. The gasket of claim 1 wherein said fabric member has a thickness of between about 2–4 mils (0.05–0.10 mm).

8. The gasket of claim 1 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

9. The gasket of claim 1 wherein said one or more flame retardant additives are selected from the group consisting of aluminum hydrate, antimony trioxide, phosphate esters, and halogenated compounds.

* * * * *

EXHIBIT C



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(12) **United States Patent**
Bunyan et al.

(10) Patent No.: **US 6,777,095 B2**

(45) Date of Patent: **Aug. 17, 2004**

(54) **FLAME RETARDANT EMI SHIELDING GASKET**

(75) Inventors: **Michael H. Bunyan, Chelmsford, MA (US); William I. Flanders, Merimack, NH (US)**

(73) Assignee: **Parker-Hannifin Corporation, Cleveland, OH (US)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/753,016**

(22) Filed: **Jan. 7, 2004**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 10/318,609, filed on Dec. 11, 2002, now Pat. No. 6,716,536, which is a continuation of application No. 10/142,803, filed on May 9, 2002, now Pat. No. 6,521,348, which is a continuation of application No. 09/883,785, filed on Jun. 18, 2001, now Pat. No. 6,387,523, which is a continuation of application No. 09/250,338, filed on Feb. 16, 1999, now Pat. No. 6,248,393.

(60) Provisional application No. 60/076,370, filed on Feb. 27, 1998.

(51) Int. Cl.⁷ **B32B 5/14; B32B 5/18; H05K 9/00**

(52) U.S. Cl. **428/457; 361/818**

(58) Field of Search **428/457; 361/818**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,178,410 A 12/1979 Tomita
 4,396,661 A 8/1983 George et al.
 4,447,484 A 5/1984 Slosberg et al.
 4,489,126 A 12/1984 Holtrop et al.
 4,531,994 A 7/1985 Holtrop et al.
 4,540,617 A 9/1985 Kawanishi et al.

4,569,304 A 2/1986 Le Maitre
 4,572,960 A 2/1986 Ebneih et al.
 4,608,104 A 8/1986 Holtrop et al.
 4,621,013 A 11/1986 Holtrop et al.
 4,666,765 A 5/1987 Caldwell et al.
 4,684,762 A 8/1987 Gladfeiter
 4,753,840 A 6/1988 Van Gompel
 4,797,171 A 1/1989 Van Gompel
 4,857,668 A 8/1989 Buonanno
 4,871,477 A 10/1989 Dimanshteyn
 4,988,550 A 1/1991 Keyser et al.
 5,009,927 A 4/1991 Cloyd et al.
 5,028,739 A 7/1991 Keyser et al.
 5,045,635 A 9/1991 Kaplo et al.

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

DE 9013936 6/1990
 EP 0326441 2/1989
 FR 2308030 12/1976
 JP 07-176889 * 7/1995

OTHER PUBLICATIONS

Dye, James M. Compliance Engineering 17(3), pp 138 and 140-145, 2000.*

Kleiner, J. Vinyl Technol. vol. 4 No. 4, Dec. 1982, pp 157-159.*

(List continued on next page.)

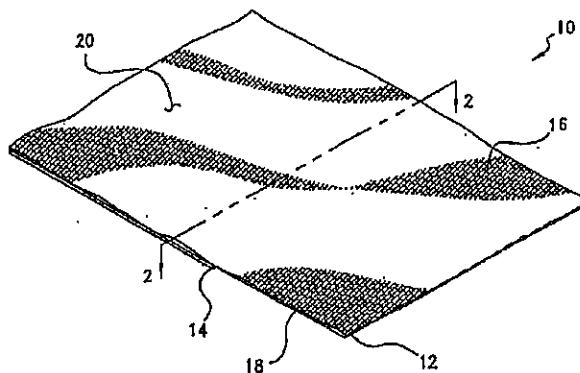
Primary Examiner—Erma Cameron

(74) *Attorney, Agent, or Firm*—John A. Molnar, Jr.

(57) **ABSTRACT**

A flame retardant, electromagnetic interference (EMI) shielding gasket construction. The construction includes a resilient core member formed of a foamed elastomeric material, an electrically-conductive fabric member surrounding the outer surface of the core member, and a flame retardant layer coating at least a portion of the interior surface of the fabric member. The flame retardant layer is effective to afford the gasket construction with a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

10 Claims, 3 Drawing Sheets



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U.S. PATENT DOCUMENTS

5,089,325 A 2/1992 Covey
5,105,056 A 4/1992 Hoge, Jr. et al.
5,122,411 A 6/1992 Iwamoto et al.
5,202,536 A 4/1993 Buonanno
5,204,403 A 4/1993 Furuta et al.
5,266,354 A 11/1993 Tohyama et al.
5,612,092 A 3/1997 Sirenger et al.
5,614,306 A 3/1997 Jobe et al.
5,635,252 A 6/1997 Fraser, Jr. et al.
5,641,544 A 6/1997 Melancon et al.
5,674,606 A 10/1997 Powers, Jr.
5,700,532 A 12/1997 Chiou

OTHER PUBLICATIONS

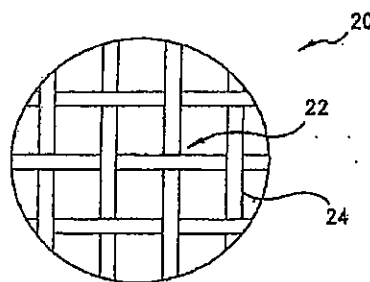
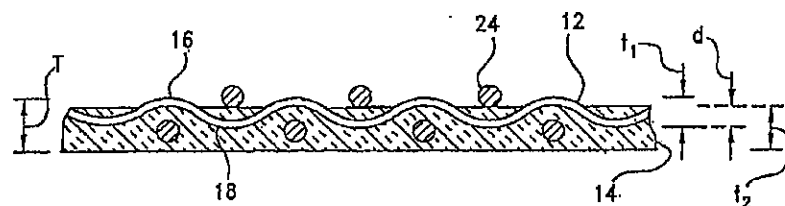
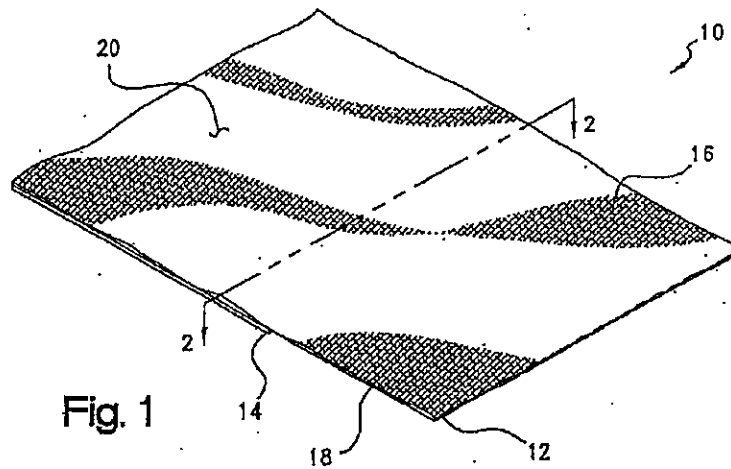
Underwriters Laboratories, Inc. letter dated Sep. 20, 1995.
Copy of the International Application Published Under the
Patent Cooperation Treaty in International Patent Applica-
tion No. PCT/US00/20609 (WO 01/10182) entitled,
"Method and Apparatus for Manufacturing A Flame Retar-
dant EMI Gasket".
Copy of International Search Report for PCT Case No.
PCT/US99/04100, Jan. 7, 1999.
Chomerics Parker Hannifin Seals Catalog dated 1997 for
Soft-Shield Low Closure force EMI Gaskets.
Monsanto Electron Metalized Materials dated Sep. 12, 1995.
* cited by examiner

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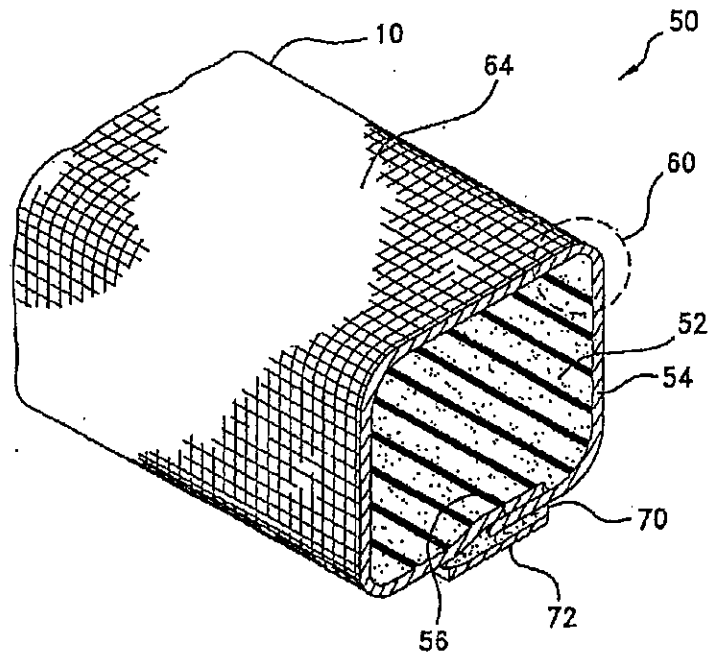


Fig. 4

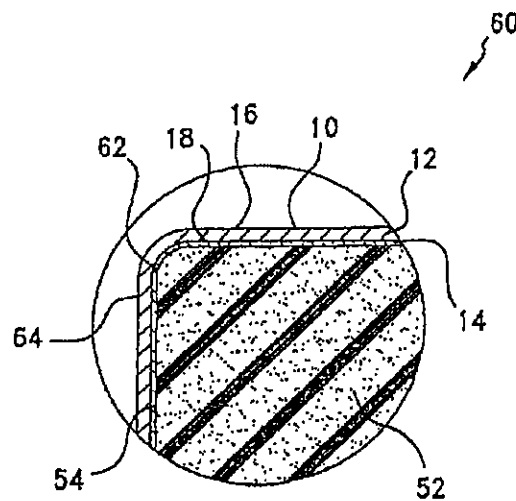


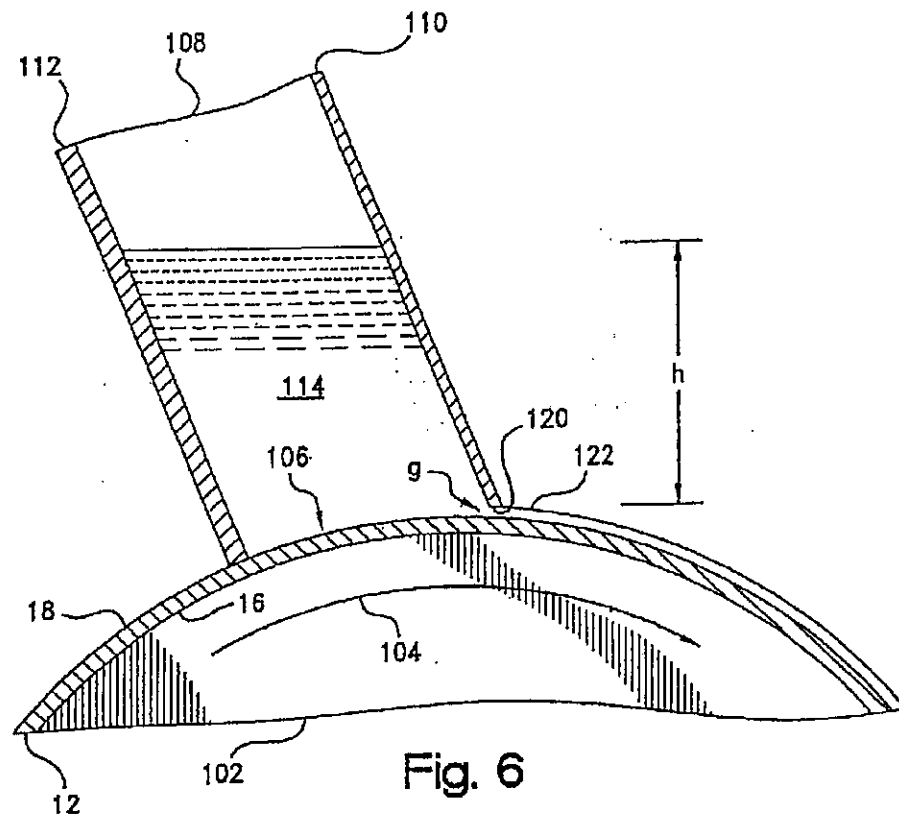
Fig. 5

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FLAME RETARDANT EMI SHIELDING GASKET

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 10/318,609, filed Dec. 11, 2002, now U.S. Pat. No. 6,716,536; which is a continuation of U.S. application Ser. No. 10/142,803, filed May 9, 2002, now U.S. Pat. No. 6,521,348; which is a continuation of U.S. application Ser. No. 09/883,785, filed Jun. 18, 2001, now U.S. Pat. No. 6,387,523; which is a continuation of U.S. application Ser. No. 09/250,338, filed Feb. 16, 1999, now U.S. Pat. No. 6,248,393 and claiming priority to U.S. Provisional application Serial No. 60/076,370, filed Feb. 27, 1998, the disclosure of each of which is expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates broadly to electrically-conductive, flame retardant materials for use in electromagnetic interference (EMI) shielding, and to a method of manufacturing the same, and more particularly to an electrically-conductive fabric having a layer of a flame retardant coating applied to one surface thereof for use as a sheathing within an EMI shielding gasket.

The operation of electronic devices including televisions, radios, computers, medical instruments, business machines, communications equipment, and the like is attended by the generation of electromagnetic radiation within the electronic circuitry of the equipment. Such radiation often develops as a field or as transients within the radio frequency band of the electromagnetic spectrum, i.e., between about 10 KHz and 10 GHz, and is termed "electromagnetic interference" or "EMI" as being known to interfere with the operation of other proximate electronic devices.

To attenuate EMI effects, shielding having the capability of absorbing and/or reflecting EMI energy may be employed both to confine the EMI energy within a source device, and to insulate that device or other "target" devices from other source devices. Such shielding is provided as a barrier which is inserted between the source and the other devices, and typically is configured as an electrically conductive and grounded housing which encloses the device. As the circuitry of the device generally must remain accessible for servicing or the like, most housings are provided with openable or removable accesses such as doors, hatches, panels, or covers. Between even the flattest of these accesses and its corresponding mating or faying surface, however, there may be present gaps which reduce the efficiency of the shielding by presenting openings through which radiant energy may leak or otherwise pass into or out of the device. Moreover, such gaps represent discontinuities in the surface and ground conductivity of the housing or other shielding, and may even generate a secondary source of EMI radiation by functioning as a form of slot antenna. In this regard, bulk or surface currents induced within the housing develop voltage gradients across any interface gaps in the shielding, which gaps thereby function as antennas which radiate EMI noise. In general, the amplitude of the noise is proportional to the gap length, with the width of the gap having a less appreciable effect.

For filling gaps within mating surfaces of housings and other EMI shielding structures, gaskets and other seals have been proposed both for maintaining electrical continuity across the structure, and for excluding from the interior of

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the device such contaminants as moisture and dust. Such seals are bonded or mechanically attached to, or press-fit into, one of the mating surfaces, and function to close any interface gaps to establish a continuous conductive path thereacross by conforming under an applied pressure to irregularities between the surfaces. Accordingly, seals intended for EMI shielding applications are specified to be of a construction which not only provides electrical surface conductivity even while under compression, but which also has a resiliency allowing the seals to conform to the size of the gap. The seals additionally must be wear resistant, economical to manufacture, and capability of withstanding repeated compression and relaxation cycles. For further information on specifications for EMI shielding gaskets, reference may be had to Severinsen, J., "Gaskets That Block EMI," *Machine Design*, Vol. 47, No. 19, pp. 74-77 (Aug. 7, 1975).

Requirements for typical EMI shielding applications often dictate a low impedance, low profile gasket which is deflectable under normal closure force loads. Other requirements include low cost and a design which provides an EMI shielding effectiveness for both the proper operation of the device and compliance, in the United States, with commercial Federal Communication Commission (FCC) EMC regulations.

A particularly economical gasket construction, which also requires very low closure forces, i.e. less than about 1 lb/inch (0.175 N/mm), is marketed by the Chomerics Division of Parker-Hannifin Corp., Woburn, Mass. under the tradename "Soft-Shield @ 5000 Series." Such construction consists of an electrically-conductive jacket or sheathing which is "cigarette" wrapped lengthwise over a polyurethane or other foam core. As is described further in U.S. Pat. No. 4,871,477, polyurethane foams generally are produced by the reaction of polyisocyanate and a hydroxyl-functional polyol in the presence of a blowing agent. The blowing agent effects the expansion of the polymer structure into a multiplicity of open or closed cells.

The jacket is provided as a highly conductive, i.e., about 1 Ω -sq., nickel-plated-silver, woven rip-stop nylon which is self-terminating when cut. Advantageously, the jacket may be bonded to the core in a continuous molding process wherein the foam is blown or expanded within the jacket as the jacket is wrapped around the expanding foam and the foam and jacket are passed through a die and into a traveling molding. Similar gasket constructions are shown in commonly-assigned U.S. Pat. No. 5,028,739 and in U.S. Pat. Nos. 4,857,668; 5,054,635; 5,105,056; and 5,202,536.

Many electronic devices, including PC's and communication equipment, must not only comply with certain FCC requirements, but also must meet be approved under certain Underwriter's Laboratories (UL) standards for flame retardancy. In this regard, if each of the individual components within an electronic device is UL approved, then the device itself does not require separate approval. Ensuring UL approval for each component therefore reduces the cost of compliance for the manufacturer, and ultimately may result in cheaper goods for the consumer. For EMI shielding gaskets, however, such gaskets must be made flame retardant, i.e., achieving a rating of V-0 under UL Std. No. 94, "Tests for Flammability of Plastic Materials for Parts in Devices and Appliances" (1991), without compromising the electrical conductivity necessary for meeting EMI shielding requirements.

In this regard, and particularly with respect to EMI shielding gaskets of the above-described fabric over foam

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variety, it has long been recognized that foamed polymeric materials are flammable and, in certain circumstances, may present a fire hazard. Owing to their cellular structure, high organic content, and surface area, most foam materials are subject to relatively rapid decomposition upon exposure to fire or high temperatures.

One approach for imparting flame retardancy to fabric over foam gaskets has been to employ the sheathing as a flame resistant protective layer for the foam. Indeed, V-0 rating compliance purportedly has been achieved by sheathing the foam within an electrically-conductive Ni/Cu-plated fabric to which a thermoplastic sheet is hot nipped or otherwise fusion bonding to the underside thereof. Such fabrics, which may be further described in one or more of U.S. Pat. Nos. 4,489,126; 4,531,994; 4,608,104; and/or 4,621,013, have been marketed by Monsanto Co., St. Louis, under the tradename "Flectron® Ni/Cu Polyester Taffeta VO."

Other fabric over foam gaskets, as is detailed in U.S. Pat. No. 4,857,668, incorporate a supplemental layer or coating applied to the interior surface of the sheath. Such coating may be a flame-retardant urethane formulation which also promotes the adhesion of the sheath to the foam. The coating additionally may function to reduce bleeding of the foam through the fabric which otherwise could compromise the electrical conductivity of the sheath.

In view of the foregoing, it will be appreciated that further improvements in the design of flame retardant, fabric-over-foam EMI shielding gaskets, as well as sheathing materials therefore, would be well-received by the electronics industry. Especially desired would be a flame retardant gasket construction which achieves a UL94 rating of V-0.

BROAD STATEMENT OF THE INVENTION

The present invention is directed to an electrically-conductive, flame retardant material for use in fabric-over-foam EMI shielding gaskets, and to a method of manufacturing the same. In having a layer of a flame retardant coating applied to one side of an electrically-conductive, generally porous fabric, the material of the invention affords UL94 V-0 protection when used as a jacketing in a fabric-over-foam gasket construction. Advantageously, as the flame retardant layer may be wet coated on the fabric without appreciable bleed through, a relatively thin, i.e., 2-4 mil (0.05-0.10 mm), coating layer may be provided on one fabric side without compromising the electrical surface conductivity of the other side. Such a thin coating layer, while being sufficient to provide UL94 V-0 protection, nonetheless maintains the drapability the fabric and thereby facilitates the construction UL94 V-0 compliant gaskets having complex profiles or narrow cross-sections down to about 1 mm.

In a preferred embodiment, the electrically-conductive, flame retardant EMI shielding material of the invention includes a nickel or silver-plated, woven nylon, polyester, or like fabric on one side of which is wet coated a layer of a flame retardant, acrylic latex emulsion or other fluent resin composition. In accordance with the precepts of the method of the invention, the viscosity and hydrodynamic pressure of the emulsion are controlled such that the coating does not penetrate or otherwise "bleed through" the uncoated side of the fabric. The surface conductivity of the opposite side of the fabric therefore is not compromised in EMI shielding applications.

The material of the invention may be employed as a jacket in fabric-over-foam EMI shielding gasket constructions, and

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is particularly adapted for use in the continuous molding process for such gaskets. As used within such process, the fabric may be wrapped around the foam as a jacket with coated side thereof being disposed as an interior surface adjacent the foam, and the uncoated side being disposed as an electrically-conductive exterior surface. Advantageously, the coating on the interior surface of the jacket blocks the pores of the fabric to retain the foam therein without penetrate or bleed through to the exterior surface. In being formed of a acrylic material, the coated interior surface of the jacket may function, moreover, depending upon the composition of the foam, as a compatibilizing or "tie" interlayer which promotes the bonding of the foam to the fabric.

The present invention, accordingly, comprises material and method possessing the construction, combination of elements, and arrangement of parts and steps which are exemplified in the detailed disclosure to follow. Advantages of the present invention include a flame retardant yet drapable EMI shielding fabric. Additional advantages include an economical, flame retardant EMI shielding fabric construction wherein a relatively thin layer of a flame retardant coating may be wet coated onto one side of an electrically-conductive, woven or other generally porous EMI shielding fabric without compromising the conductivity of the other side of the fabric. These and other advantages will be readily apparent to those skilled in the art based upon the disclosure contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of one embodiment of an EMI shielding material according to the present invention which material includes a generally planar fabric member on one side of which is coated a layer of a flame retardant composition, the view being shown with portions being broken away to better reveal the structure of the material;

FIG. 2 is an enlarged cross-sectional view of the EMI shielding material of FIG. 1 taken through plane represented by line 2-2 of FIG. 1;

FIG. 3 is a top view of the material of FIG. 1 which is magnified to reveal the structure of the fabric member thereof;

FIG. 4 is a perspective cross-sectional view of a length of a representative EMI shielding gasket construction according to the present invention including a jacket which is formed of the EMI shielding material of FIG. 1;

FIG. 5 is an end view of the gasket of FIG. 4 which is magnified to reveal the structure thereof; and

FIG. 6 is a schematic, partially cross-sectional view of an illustrative gravity-fed, knife over roll coater as adapted for use in the manufacture of the EMI shielding material of FIG. 1.

The drawings will be described further in connection with the following Detailed Description of the Invention.

DETAILED DESCRIPTION OF THE INVENTION

Certain terminology may be employed in the description to follow for convenience rather than for any limiting purpose. For example, the terms "upper" and "lower" designate directions in the drawings to which reference is made,

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with the terms "inner" or "interior" and "outer" or "exterior" referring, respectively, to directions toward and away from the center of the referenced element, and the terms "radial" and "axial" referring, respectively, to directions perpendicular and parallel to the longitudinal central axis of the referenced element. Terminology of similar import other than the words specifically mentioned above likewise is to be considered as being used for purposes of convenience rather than in any limiting sense.

For the illustrative purposes of the discourse to follow, the electromagnetic interference (EMI) shielding material herein involved is described in connection with its use as a flame retardant, electrically-conductive jacket for a foam core, EMI shielding gasket as may be adapted to be received within an interface, such as between a door, panel, hatch, cover, or other parting line of an electromagnetic interference (EM) shielding structure. The EMI shielding structure may be the conductive housing of a computer, communications equipment, or other electronic device or equipment which generates EMI radiation or is susceptible to the effects thereof. The gasket may be bonded or fastened to, or press-fit into one of a pair of mating surfaces which define the interface within the housing, and functions between the mating surfaces to seal any interface gaps or other irregularities. That is, while under an applied pressure, the gasket resiliently conforms to any such irregularities both to establish a continuous conductive path across the interface, and to environmentally seal the interior of the housing against the ingress of dust, moisture, or other contaminants. It will be appreciated, however, that aspects of the present invention may find utility in other EMI shielding applications. Use within those such other applications therefore should be considered to be expressly within the scope of the present invention.

Referring then to the figures, wherein corresponding reference characters are used to designate corresponding elements throughout the several views, a flame retardant EMI shielding material according to the present invention is shown generally at 10 in FIG. 1 as generally adapted for use as a jacket within for a foam core gasket construction. For purposes of illustration, material sheet 10 is shown to be of indefinite dimensions which may be cut to size for the particular application envisioned. In basic construction, material 10 includes an upper, generally planar and porous fabric member, 12, and a lower, flame retardant coating member, 14.

Fabric member has at least an electrically-conductive first side, 16, and a conductive or non-conductive second side, 18, defining a thickness dimension, referenced at "t₁" in the cross-sectional view of FIG. 2, which may vary from about 2-4 mils (0.05-0.10 mm). By "electrically-conductive," it is meant that the fabric may be rendered conductive, i.e., to a surface resistivity of about 0.1 Ω /sq. or less, by reason of its being constructed of electrically-conductive wire, monofilaments, yarns or other fibers or, alternatively, by reason of a treatment such as a plating or sputtering being applied to non-conductive fibers to provide an electrically-conductive layer thereon. Preferred electrically-conductive fibers include Monel nickel-copper alloy, silver-plated copper, nickel-clad copper, Ferrex® tin-plated copper-clad steel, aluminum, tin-clad copper, phosphor bronze, carbon, graphite, and conductive polymers. Preferred non-conductive fibers include cotton, wool, silk, cellulose, polyester, polyamide, nylon, and polyimide monofilaments or yarns which are rendered electrically conductive with a metal plating of copper, nickel, silver, nickel-plated-silver, aluminum, tin, or an alloy thereof. As is known, the metal

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plating may applied to individual fiber strands or to the surfaces of the fabric after weaving, knitting, or other fabrication.

While fabrics such as wire meshes, knits, and non-woven cloths and webs may find application, a preferred fabric construction for member 12 is a plain weave nylon or polyester cloth which is made electrically conductive with between about 20-40% by weight based on the total fabric weight, i.e., 0.01-0.10 g/in², of a silver, nickel-silver, or silver-nickel over copper plating. As may be seen in the magnified view of FIG. 1 referenced at 20 in FIG. 3, such cloth is permeable in having a plain, generally square weave pattern with pores or openings, one of which is referenced at 22, being defined between the fibers which are represented schematically at 24. Fibers 24 may be yarns, monofilaments or, preferably, bundles of from about 10-20 filaments or threads, each having a diameter of between about 10-50 μ m. For example, with fibers 24 each being a bundle of such threads with a thread count of between about 1000-3000 per inch and a weave count of between about 1000-1500 per inch, 1000-2000 openings per inch will be defined with a mean average pore size of between about 0.5-2 mils (12.5-50 μ m).

Although a plain, square weave pattern such as a taffeta, tabby, or ripstop is considered preferred, other weaves such as satins, twills, and the like also should be considered within the scope of the invention herein involved. A particularly preferred cloth for fabric member 12 is a 4 mil (0.10 mm) thick, 1.8 oz/yd² weight, silver-plated, woven nylon which is marketed commercially under the designation "31EN RIPSTOP" by Swift Textile Metalizing Corp., Bloomfield, Conn. However, depending upon the needs of the specific shielding application, a fabric constructed of a combination or blend of conductive and nonconductive fibers alternatively may be employed. Examples of fabrics woven, braided, or warp knitted from electrically-conductive fibers, or from blends of conductive and non-conductive fibers, are described in Gladfelter, U.S. Pat. No. 4,684,762, and in Buonanno, U.S. Pat. No. 4,857,668.

Returning to FIGS. 1 and 2, coating member 14 preferably is formed from a curable layer of a fluent, flame retardant resin or other composition which is wet coated onto the second side 18 of fabric member 12. As is detailed hereinafter, the viscosity and hydrodynamic pressure of the resin composition are controlled in accordance with the precepts of the present invention to delimit the penetration of the resin layer to a depth, referenced at "d" in FIG. 2, which is less than the thickness dimension t₁ of the fabric member 12. In this regard, when the layer is cured to form the flame retardant surface coating member 14 on the second side 18 of fabric member 12, the first side 16 thereof remains electrically-conductive. In a preferred construction, the layer is coated to a wet thickness of about 10 mils (0.25 mm), and then cured to a dried coating or film thickness, referenced at t₂ in FIG. 2, of between about 2-4 mils (0.05-0.10 mm) at a depth d of about 1-2 mils (0.025-0.05 mm). Ultimately, a total material thickness, referenced at "T," of between about 6-7 mils (0.15-0.20 mm) and a dried weight pickup of between about 100-150 g/yd² are observed. By "cured" it is meant that the resin is polymerized, cross-linked, further cross-linked or polymerized, vulcanized, hardened, dried, volatilized, or otherwise chemically or physically changed from a liquid or other fluent form into a solid polymeric or elastomeric phase.

The flame retardant composition preferably is formulated as an aqueous emulsion of an acrylic latex emulsion which is adjusted to a total solids of about 60% and a Brookfield

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viscosity (#5 spindle, 4 speed) of between about 40,000–60,000 cps, at a density of about 10 lbs per gallon (1.8 g/cm³). Flame retardancy may be imparted by loading the emulsion with between about 30–50% by weight of one or more conventional flame retardant additives such as aluminum hydrate, antimony trioxide, phosphate esters, or halogenated compounds such as polybrominated diphenyl oxides. A preferred formulation is a mixture of about 25% by weight, based on the total weight of the emulsion, of decabromodiphenyl oxide and about 15% by weight of one or more antimony compounds. In operation, should the acrylic carrier phase be ignited, the decomposition of the halogenated and metal oxide compounds function to chemically deprive the flame of sufficient oxygen to support combustion. The decomposition of the acrylic phase additionally may lead to the development of a protective, i.e., thermally-insulative or refractory, outer char layer.

A preferred flame retardant, acrylic latex emulsion is marketed commercially by Heveatex Corp., Fall River, Mass., under the designation "4129FR." The viscosity of the emulsion may be adjusted to between about 40,000–60,000 cps using an aqueous acryloid get or other acrylic thickener. In this regard, the increased viscosity of the emulsion contributes to delimiting the penetration of the coating layer into the fabric member. However, as this relatively high viscosity may lead to undesirable porosity in the dried film, the emulsion additionally may be modified to reduce air entrapment and bubble formation in the coating layer with up to about 1% by weight of one or more commercial surfactants such as "Bubble Breaker" by Witco Chemical Corp. (Chicago, Ill.) and "Foam Master Antifoam" by Diamond Shamrock, Inc. (San Antonio, Tex.).

As aforementioned, EMI shielding material 10 of the present invention is particularly adapted for use as a flame retardant, electrically-conductive jacket which is provided over a foam core in an EMI shielding gasket construction such as gasket 50 of FIG. 4. In a representative embodiment, gasket 50 includes an elongate, resilient foam core member, 52, which may be of an indefinite length. Core member 52 has an outer circumferential surface, 54, defining the cross-sectional profile of gasket 50 which, for illustrative purposes, is of a generally polygonal, i.e., square or rectangular geometry. Other plane profiles, such as circular, semi-circular, or elliptical, or complex profiles may be substituted, however, depending upon the geometry of the interface to be sealed. Core member 12 may be of any radial or diametric extent, but for most applications will have a diametric extent or width of from about 0.25 inch (0.64 cm) to 1 inch (2.54 cm).

For affording gap-filling capabilities, it is preferred that core member 52 is provided to be compliant over a wide range of temperatures, and to exhibit good compression-relaxation hysteresis even after repeated cyclings or long compressive dwells. Core member 52 therefore may be formed of a foamed elastomeric thermoplastic such as a polyethylene, polypropylene, polypropylene-EPDM blend, butadiene, styrene-butadiene, nitrile, chlorosulfonate, or a foamed neoprene, urethane, or silicone. Preferred materials of construction include open or closed cell urethanes or blends such as a polyolefin resin/monolefin copolymer blend, or a neoprene, silicone, or nitrile sponge rubber.

Core member 52 may be provided as an extruded or molded foam profile over which shielding material 10 is wrapped as a sheathed, with the edges of sheathed being overlapped as at 56. In a preferred construction, shielding material 10 is bonded to the core member 52 in a continuous molding process wherein the foam is blown or expanded

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within the shielding material. As may be seen best with reference to the magnified view of FIG. 4 referenced at 60 in FIG. 5, in such construction coating member 14 is disposed adjacent core member 52 as an interior surface, 62, of shielding member 10, with the uncoated side 16 of fabric member 12 being oppositely disposed as an electrically-conductive exterior surface, 64, of the gasket 50. It will be appreciated that the coated interior surface 62 blocks the pores 22 (FIG. 3) of the fabric member 12 of the fabric to retain the blown foam therein without penetrate or bleed through to the exterior gasket surface 64. Depending upon the respective compositions of the foam and coating, the interior surface 62 may function, moreover, as a compatibilizing or "tie" interlayer which promotes the bonding of the foam to the fabric. Gasket construction 50 advantageously provides a structure that may be used in very low closure force, i.e. less than about 1 lb/inch (0.175 N/mm), applications.

Referring again to FIG. 4, an adhesive layer, 70, may be applied along the lengthwise extent of gasket 50 to the underside of exterior surface 64 for the attachment of the gasket to a substrate. Such layer 70 preferably is formulated to be of a pressure sensitive adhesive (PSA) variety. As is described in U.S. Pat. No. 4,988,550, suitable PSA's for EMI shielding applications include formulations based on silicones, neoprene, styrene butadiene copolymers, acrylics, acrylates, polyvinyl ethers, polyvinyl acetate copolymers, polyisobutylenes, and mixtures, blends, and copolymers thereof. Acrylic-based formulations, however, generally are considered to be preferred for the EMI applications of the type herein involved. Although PSA's are preferred for adhesive layer 70, other adhesives such as epoxies and urethanes may be substituted and, accordingly, are to be considered within the scope of the present invention. Heat-fusible adhesives such as hot-melts and thermoplastic films additionally may find applicability.

Inasmuch as the bulk conductivity of gasket 50 is determined substantially through its surface contact with the substrate, an electrically-conductive PSA may be preferred to ensure optimal EMI shielding performance. Such adhesives conventionally are formulated as containing about 1–25% by weight of a conductive filler to yield a volume resistivity of from about 0.01–0.001 Ω -cm. The filler may be incorporated in the form of particles, fibers, flakes, microspheres, or microballoons, and may range in size of from about 1–100 microns. Typically filler materials include inherently conductive material such as metals, carbon, and graphite, or nonconductive materials such as plastic or glass having a plating of a conductive material such as a noble metal or the like. In this regard, the means by which the adhesive is rendered electrically conductive is not considered to be a critical aspect of the present invention, such that any means achieving the desired conductivity and adhesion are to be considered suitable.

For protecting the outer portion of adhesive layer 70 which is exposed on the exterior surface of the gasket, a release sheets, shown at 72, may be provided as removably attached to the exposed adhesive. As is common in the adhesive art, release sheet 72 may be provided as strip of a waxed, siliconized, or other coated paper or plastic sheet or the like having a relatively low surface energy so as to be removable without appreciable lifting of the adhesive from the exterior surface 64.

In the production of commercial quantities of the EMI shielding material 10 of the present invention, the viscosity adjusted and otherwise modified acrylic latex emulsion or other resin composition may be coated and cured on one side

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the fabric member 12 by a direct wet process such as knife over roll or slot die. With whatever process is employed, the hydrodynamic pressure of the resin composition is controlled in accordance with the precepts of the present invention to delimit the penetration of the resin layer to a depth which is less than the thickness dimension of the fabric member. For example, and with reference to FIG. 6 wherein the head of a representative gravity-fed knife over roll coater is shown somewhat schematically at 100, porous, i.e., permeable, fabric member 12 is conveyed from a feed roll or the like (not shown) over a nip roller, 102, which rotates in the direction referenced by arrow 104. With the first side 16 of fabric member 12 supported on roller 102, the fabric second side 18 is passed beneath the opening, referenced at 106, of a coating trough, 108. Trough 108 is defined by a front plate, 110, a back plate, 112, and a pair of side plates (not shown).

The emulsion or other fluent resin composition, referenced at 114, is pumped or otherwise transported into trough 108 which is filled to a fluid level, referenced at h. For a given fluid density, this level h is controlled such that the hydrodynamic pressure at the fabric-liquid interface is maintained within preset limits. For example, with a fluid density of about 10 pounds per gallon (1.8 g/cm³), and a fabric having a porosity of about 1000-2000 openings per inch with a mean average pore size of between about 0.5-2 mils (12.5-50 μ m), the fluid level H is controlled at about 4 inches (10 cm) to yield a hydrodynamic pressure of about 0.05 psi (0.35 kPa) at the fabric-liquid interface. For other coating processes, the hydrodynamic fluid pressure may be controlled, for example, by a pumping pressure or the like.

In the illustrative knife-over-roll coating process, the lower edge, 120, of front plate 110 defines a knife surface which is shimmed or otherwise spaced-apart a predetermined distance from the second side 18 of fabric member 12. Such spacing provides a clearance or gap, referenced at "g," of typically about 10 mils (0.25 mm), but which is adjustable to regulate the thickness of the liquid coating layer, 122, being applied to the fabric member. From roller 104, the coated fabric member 12 may be conveyed via a take-up roller arrangement (not shown) through a in-line oven or the like to dry or flash the water or other diluent in the liquid coating layer 122, or to otherwise cure the liquid coating layer 122 in developing an adherent, tack-free, film or other layer of coating member 14 (FIG. 1) on the single side 18 of fabric member 12.

The Example to follow, wherein all percentages and proportions are by weight unless otherwise expressly indicated, is illustrative of the practicing of the invention herein involved, but should not be construed in any limiting sense.

EXAMPLE

Representative EMI shielding materials according to the present invention were constructed for characterization. In this regard, a master batch of a flame retardant coating composition was compounded using an acrylic latex emulsion (Heveatex "4129FR"). The viscosity of the emulsion was adjusted to a Brookfield viscosity (#4 spindle, 40 speed) of about 60,000 cps with about 5wt % of an acryloid thickener (Acrysol™GS, Monsanto Colo., St. Louis, Mo.). The modified emulsion had a total solids content of about 60% by weight, a density of about 10 pounds per gallon (1.8 g/cm³), and a pH of between about 7.5 and 9.5.

The emulsion was applied using a knife over roll coater (JETZONE Model 7319, Wolverine Corp., Merrimac,

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Mass.) to one side of a silver-plated nylon fabric (Swift "31EN RIPSTOP") having a thickness of about 4 mils (0.1 mm). With the fluid level in the coating trough of the coater maintained at about 4 inch (10 cm), the emulsion was delivered to the surface of the cloth at a hydrodynamic pressure of about 0.05 psi (0.35 kPa). The coating knife was shimmed to a 10 mil (0.25 mm) gap above the fabric to yield a wet coating draw down thickness of about 10 mils. Following an oven curing at 100-125° C. for 5 minutes, a dried coating or film thickness of about 2.5 mils (0.635 mm) was obtained with a weight pickup of about 130-145 g/yd² and a total material thickness of between about 6-7 mils (0.15-0.18 mm). An inspection of the coated fabric cloth revealed a coating penetration depth of about 1-2 mils (0.02-0.05 mm) providing acceptable mechanical retention and/or adhesion of the coating onto the fabric surface. The opposite side of the fabric, however, was observed to be substantially coating free, and to retain a surface resistivity of about 0.1 Ω /sq for unaffected EMI shielding effectiveness.

Fabric samples similarly coated in the manner described were subjected to an in-house vertical flame test. No burning was observed at dried film thickness of 2, 3, or 4 mils (0.05, 0.08, 0.10 mm). Accordingly, a reasonable operating window of film thickness was suggested for production runs.

Samples also were provided, as jacketed over a polyurethane foam core in an EMI shielding gasket construction, for flame testing by Underwriters Laboratories, Inc., Melville, N.Y. A flame class rating of V-0 under UL94 was assigned at a minimum thickness of 1.0 mm. The gasket construction therefore was found to be compliant with the applicable UL requirements, and was approved to bear the "UL" certification mark.

The foregoing results confirm that the EMI shielding material of the present invention affords UL94 V-0 protection when used as a jacketing in a fabric-over-foam gasket construction. Unexpectedly, it was found that a relatively porous or permeable fabric may be wet coated on one side with a relatively thin, i.e., 2-4 mil (0.05-0.10 mm), coating layer of a flame retardant composition without compromising the electrical surface conductivity of the other side. Such a thin coating layer, while being sufficient to provide UL94 V-0 protection in a conventional fabric-over-foam gasket construction, nonetheless maintains the drapability the fabric and thereby facilitates the fabrication of UL94 V-0 compliant gaskets having complex profiles or narrow cross-sections down to about 1 mm.

As it is anticipated that certain changes may be made in the present invention without departing from the precepts herein involved, it is intended that all matter contained in the foregoing description shall be interpreted as illustrative and not in a limiting sense. All references cited herein are expressly incorporated by reference.

What is claimed is:

1. A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;

an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being

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- electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and
- a flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprising at least about 50% by dry weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.
2. The gasket of claim 1 wherein said flame retardant layer has a thickness of between about 2-4 mils (0.05-0.10 mm).
3. The gasket of claim 1 wherein said flame retardant layer is formed as a cured film of a flame retardant acrylic latex emulsion.
4. The gasket of claim 1 wherein said fabric member is a metal-plated cloth.
5. The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group

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consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.

6. The gasket of claim 1 wherein said foamed elastomeric material is selected from the group consisting of polyethylenes, polypropylenes, polypropylene-EPDM blends, butadienes, styrene-butadienes, nitriles, chlorosulfonates, neoprenes, urethanes, silicones, and polyolefin resin/monoolefin copolymer blends, and combinations thereof.

7. The gasket of claim 1 wherein said fabric member has a thickness of between about 2-4 mils (0.05-0.10 mm).

8. The gasket of claim 1 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

9. The gasket of claim 1 wherein said one or more flame retardant additives are selected from the group consisting of aluminum hydrate, antimony trioxide, phosphate esters, and halogenated compounds.

10. The gasket of claim 1 wherein said flame retardant layer comprises between about 50-83% by dry weight of one or said one or more flame retardant additives.

* * * * *

EXHIBIT D

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

PARKER HANNIFIN CORPORATION,)

Plaintiff,)

v.)

SEIREN CO., LTD.,)

Defendant.)

Civil Action No. 07-cv- 00104-***

**ANSWERS AND OBJECTIONS TO DEFENDANT'S FIRST SET OF
INTERROGATORIES DIRECTED TO PLAINTIFF**

In accordance with Rules 26 and 33 of the Federal Rules of Civil Procedure, Plaintiff, Parker-Hannifin Corporation ("Parker"), hereby responds to the First Set of Interrogatories filed by Seiren Co., Ltd. ("Seiren").

GENERAL OBJECTIONS

Parker incorporates herein and in each and every response below the General Objections set forth in its Objections and Responses to Seiren's First Set of Requests for Production of Documents and Things.

INTERROGATORIES

INTERROGATORY NO. 1:

Describe YOUR policies and practices with respect to the filing, storage, retention, and destruction of documents from 1996 to present, and identify the persons most knowledgeable with respect thereto, any document retention or destruction manual, and any other documents constituting or describing YOUR document retention or destruction policy or practice.

RESPONSE TO INTERROGATORY NO. 1:

Plaintiff objects to this Interrogatory as over broad, vague and ambiguous. Plaintiff objects to this Interrogatory to the extent that it calls for information not relevant to any claim or defense in this case, and to the extent that responding to the Interrogatory as written would be overly burdensome. Subject to and without waiving these objections, Plaintiff responds in part by exercising its right to produce business records pursuant to Fed. R. Civ. P. 33(d). The answer to the Interrogatory may be derived from Plaintiff's Policy Statement regarding Records Retention and Protection and its appendix Guidelines for Record Retention. The documents will be produced or made available for inspection and copying at the offices of Connolly Bove Lodge & Hutz LLP, 1007 North Orange Street, Wilmington, Delaware 19899 ("Connolly Bove"). By way of further answer, Plaintiff identifies William Lionetta as the person most knowledgeable about the filing, storage, retention, and destruction of documents.

INTERROGATORY NO. 2:

IDENTIFY each claim of each PATENT-IN-SUIT that YOU contend DEFENDANT has infringed or is infringing, including, for each identified claim, identifying the product, device or process of DEFENDANT that YOU contend has infringed or currently infringes the identified claim.

RESPONSE TO INTERROGATORY NO. 2:

Plaintiff objects to this Interrogatory on the grounds that it is premature. Plaintiff also objects because the Interrogatory calls for information requiring an underlying legal conclusion. Plaintiff objects to this Interrogatory to the extent that it seeks information protected by the attorney-client privilege and/or work product doctrine. Subject to and without waiving these objections, Plaintiffs respond as follows. Based on the information

presently available to it, Plaintiffs believes that at least the products having the product number or designations Sui-13-70FR, Sui-14-95BFR, Sui-13-63NF and Sui-13-63FMV (hereinafter collectively "the Seiren Fabrics") are infringing or have been used in a manner that infringes at least the following claims of the patents-in-suit:

U.S. Pat. No. 6,521,348 ("the '348 patent") claims 1, 4, 5, 8, 11, 12 and 15;

U.S. Pat. No. 6,716,536 ("the '536 patent") claims 1, 4, 5 and 8; and

U.S. Pat. No. 6,777,095 ("the '095 patent") claims 1, 4, 5, 8 and 10.

Discovery is continuing and Plaintiff is investigating the claims and defenses. Plaintiff will supplement its answer to this Interrogatory pursuant to the requirements of Fed. R. Civ. P. 26(e).

INTERROGATORY NO. 3:

For each accused product, device or process identified in the answer to Interrogatory No. 2, provide a claim chart or its equivalent specifying how YOU contend each element of each claim is infringed by DEFENDANT, including whether such alleged infringement is direct, contributory, by inducement, or under the doctrine of equivalents.

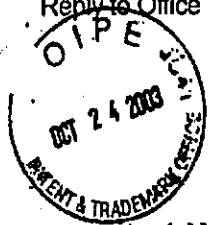
RESPONSE TO INTERROGATORY NO. 3:

Plaintiff objects to this Interrogatory on the grounds that it is premature. Plaintiff also objects because the Interrogatory calls for information requiring an underlying legal conclusion. Plaintiff objects to this Interrogatory to the extent that it seeks information protected by the attorney-client privilege and/or work product doctrine. Subject to and without waiving these objections, Plaintiff responds as follows. The Seiren Fabrics are used to construct products that directly infringe at least the claims identified in response to Interrogatory No. 2. Seiren is liable at least for inducing infringement and/or

EXHIBIT E

EXHIBIT E

Appl. No. Serial No. 10/318,609
Amdt. dated October 21, 2003
Reply to Office action of July 17, 2003



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 10/318,609
Applicant : Bunyan, *et al.*
Filed : December 11, 2002
Title : Flame Retardant EMI Shielding Gasket

TC/A.U. : 1762
Examiner : Erma C. Cameron
Docket No. : 2802-257-023

RECEIVED
OCT 31 2003
TC 1700

Honorable Commissioner For Patents
Alexandria, VA 22313-1450

AMENDMENT

In response to the Office action of July 17, 2003, please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks begin on page 4 of this paper.

Appl. No. Serial No. 10/318,609
Amdt. dated October 21, 2003
Reply to Office action of July 17, 2003

This listing of claims will replace all prior versions, and listing, of claims in the application.

Listing of Claims:

Claim 1 (currently amended): A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;

an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and

a flame retardant layer coating at least a portion of the interior surface of said fabric member, ~~said flame retardant layer being effective to afford said gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94~~ comprising at least about 30% by weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

Claim 2 (original): The gasket of claim 1 wherein said flame retardant layer has a thickness of between about 2-4 mils (0.05-0.10 mm).

Claim 3 (currently amended): The gasket of claim 1 wherein said flame retardant layer [of] is formed as a cured film of a flame retardant acrylic latex emulsion.

Claim 4 (original): The gasket of claim 1 wherein said fabric member is a metal-plated cloth.

Appl. No. Serial No. 10/318,609
Amdt. dated October 21, 2003
Reply to Office action of July 17, 2003

Claim 5 (original): The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.

Claim 6 (original): The gasket of claim 1 wherein said foamed elastomeric material is selected from the group consisting of polyethylenes, polypropylenes, polypropylene-EPDM blends, butadienes, styrene-butadienes, nitriles, chlorosulfonates, neoprenes, urethanes, silicones, and polyolefin resin/monoolefin copolymer blends, and combinations thereof.

Claim 7 (original): The gasket of claim 1 wherein said fabric member has a thickness of between about 2-4 mils (0.05-0.10 mm).

Claim 8 (new): The gasket of claim 1 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

Claim 9 (new): The gasket of claim 1 wherein said one or more flame retardant additives are selected from the group consisting of aluminum hydrate, antimony trioxide, phosphate esters, and halogenated compounds.

Appl. No. Serial No. 10/318,609
Amdt. dated October 21, 2003
Reply to Office action of July 17, 2003

REMARKS

Reconsideration of the above-identified application as amended respectfully is solicited on behalf of the Applicants

With the instant response, 2 claims have been amended and 2 claims have been newly added. A terminal disclaimer is filed herewith.

Claim 3 has been corrected to comply with 35 U.S.C. § 112, second paragraph.

Claims 1-7 have been rejected under 35 U.S.C. § 112, first paragraph. As to claim 1, the claim has been amended in the interest of clarity to recite that "at least the exterior surface [of the fabric member is] electrically-conductive and the exterior surface defin[es] with the interior surface a thickness dimension of the fabric member therebetween," and further that the flame retardant layer "penetrat[es] into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive."

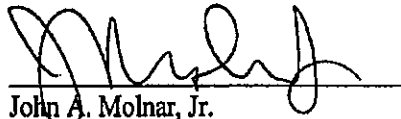
It is noted that claims 1-7 have been rejected for obviousness-type double patenting as being unpatentable over claims 1-8 of U.S. Patent No. 6,387,523. In order to materially advance the status of the present prosecution, a terminal disclaimer in compliance with 37 C.F.R. § 1.321(b) is filed herewith. The certification required under 37 C.F.R. § 3.73 accompanies the disclaimer.

As to claim 1 as amended, the claim now recites that the flame retardant layer comprises at least about 30% by weight of one or more flame retardant additives. In this regard, it is believed that the adhesive or other layers previously used in the art were not so highly loaded with flame retardant additives such that a gasket constructed therewith could achieve a UL rating of V0 notwithstanding that the other component parts thereof, namely the core, were not in and of themselves substantially flame retardant. Rather, it is believed that conventional wisdom called for each of the components of the gasket to be V0-rated or otherwise substantially flame retardant for achieving an overall gasket construction having a V0 rating. It remained for the instant Applicants, however, to recognize that a V0-rated gasket could be constructed without the core itself having to be V0-rated or otherwise highly loaded with flame retardant additives. Advantageously, Applicants' recognition allows for a flame retardant gasket to be produced having physical properties, such as high compressibility and resistance to compression set, which approach those of standard gaskets. In contrast, the V0 gaskets which heretofore may have been known in the art are believed to have exhibited relatively poor physical properties as a result of the core having been highly loaded with the large amount of flame retardant additives.

Appl. No. Serial No. 10/318,609
Amdt. dated October 21, 2003
Reply to Office action of July 17, 2003

In view of the foregoing, wherein the claim program is believed to distinguish over the art made of record, the issuance of a Notice of Allowance is earnestly solicited.

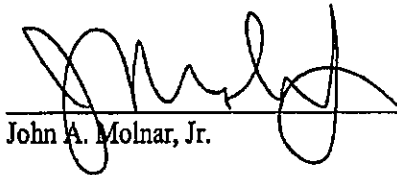
Respectfully submitted,



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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited on October 21, 2003, with the United Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.



John A. Molnar, Jr.

EXHIBIT F

~~EXHIBIT F~~

Appl. No. Serial No. 10/753,016
Amdt. dated March 10, 2004
Prelim. Amdt. under 37 C.F.R. § 1.115



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 10/753,016
Applicant : Bunyan, *et al.*
Filed : January 7, 2004
Title : Flame Retardant EMI Shielding Gasket

TC/A.U. :
Examiner :
Docket No. : 2802-257-023

Honorable Commissioner For Patents
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT UNDER 37 C.F.R. § 1.115

Pursuant to 37 C.F.R. § 1.115, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of the claims which begins on page 2 of this paper.

Remarks begin on page 4 of this paper.

Appl. No. Serial No. 10/753,016
Amdt. dated March 10, 2004
Prelim. Amdt. under 37 C.F.R. § 1.115

This listing of claims will replace all prior versions, and listing, of claims in the application.

Listing of Claims:

Claim 1 (currently amended): A flame retardant, electromagnetic interference (EMI) shielding gasket comprising:

a resilient core member extending lengthwise along a central longitudinal axis and having an outer surface extending circumferentially about said longitudinal axis, said core member being formed of a foamed elastomeric material;

an electrically-conductive fabric member surrounding the outer surface of said core member, said fabric member having an interior surface disposed facing the outer surface of said core member and an oppositely-facing, exterior surface, at least the exterior surface being electrically-conductive and the exterior surface defining with the interior surface a thickness dimension of the fabric member therebetween; and

a flame retardant layer coating at least a portion of the interior surface of said fabric member, ~~said flame retardant layer being effective to afford said gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94~~ comprising at least about 50% by dry weight of one or more flame retardant additives and penetrating into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive.

Claim 2 (original): The gasket of claim 1 wherein said flame retardant layer has a thickness of between about 2-4 mils (0.05-0.10 mm).

Claim 3 (currently amended): The gasket of claim 1 wherein said flame retardant layer [of] is formed as a cured film of a flame retardant acrylic latex emulsion.

Claim 4 (original): The gasket of claim 1 wherein said fabric member is a metal-plated cloth.

Appl. No. Serial No. 10/753,016
Amdt. dated March 10, 2004
Prelim. Amdt. under 37 C.F.R. § 1.115

Claim 5 (original): The gasket of claim 4 wherein said cloth comprises fibers selected from the group consisting of cotton, wool, silk, cellulose, polyester, polyamide, nylon, and combinations thereof, and said metal is selected from the group consisting of copper, nickel, silver, nickel-plated-silver, aluminum, tin, and combinations thereof.

Claim 6 (original): The gasket of claim 1 wherein said foamed elastomeric material is selected from the group consisting of polyethylenes, polypropylenes, polypropylene-EPDM blends, butadienes, styrene-butadienes, nitriles, chlorosulfonates, neoprenes, urethanes, silicones, and polyolefin resin/monoolefin copolymer blends, and combinations thereof.

Claim 7 (original): The gasket of claim 1 wherein said fabric member has a thickness of between about 2-4 mils (0.05-0.10 mm).

Claim 8 (new): The gasket of claim 1 wherein said flame retardant layer is effective to afford the gasket a flame class rating of V-0 under Underwriter's Laboratories (UL) Standard No. 94.

Claim 9 (new): The gasket of claim 1 wherein said one or more flame retardant additives are selected from the group consisting of aluminum hydrate, antimony trioxide, phosphate esters, and halogenated compounds.

Claim 10 (new): The gasket of claim 1 wherein said flame retardant layer comprises between about 50-83% by dry weight of one or said one or more flame retardant additives.

Appl. No. Serial No. 10/753,016
Amdt. dated March 10, 2004
Prelim. Amdt. under 37 C.F.R. § 1.115

REMARKS

Consideration of the above-identified application as amended respectfully is solicited on behalf of the Applicants. With the instant response, 2 claims have been amended and 3 claims have been newly added.

A terminal disclaimer is filed herewith in compliance with 37 C.F.R. § 1.321(b) is filed herewith. The certification required under 37 C.F.R. § 3.73 accompanies the disclaimer.

Claim 1 has been amended in the interest of clarity to recite that "at least the exterior surface [of the fabric member is] electrically-conductive and the exterior surface defin[es] with the interior surface a thickness dimension of the fabric member therebetween," and further that the flame retardant layer "penetrat[es] into said fabric member to a depth which is less than the thickness dimension of said fabric member such that the exterior surface of said fabric member remains electrically-conductive."

Claim 1 also has been amended to recite that the flame retardant layer coating at least a portion of the interior surface of said fabric member, said flame retardant layer comprises at least about 50% by dry weight of one or more flame retardant additives. Support for the amendment may be found at page 10, lines 7-15 of the instant specification as filed, and further in the Example at page 14, lines 23-24.

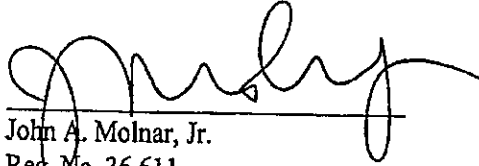
In this regard, the specification describes the 30-50% range is based on the total weight of the emulsion. With the emulsion having a total solids content of about 60%, such 30-50% range therefore corresponds to a dry weight basis in the dried or otherwise cured film of the layer [See Specification, at page 14, lines 4-8], of between about 50-83%. For example, at 60% total solids, 100 parts by total weight of the emulsion contains 30-50 parts of the one or more flame retardant additives, and 60 parts by weight solids. On a solid or dry basis, *i.e.*, with the 40 parts water having been removed, the total weight of the layer is now 60 parts with between about 30-50 parts thereof, *i.e.*, about 50-83%, being the additive composition or concentration.

Claim 3 has been amended to correct an informality.

Appl. No. Serial No. 10/753,016
Amdt. dated March 10, 2004
Prelim. Amdt. under 37 C.F.R. § 1.115

As the present claim program is believed to properly distinguish over the art of record, an early notice of allowance respectfully is solicited.

Respectfully submitted,



John A. Molnar, Jr.

Reg. No. 36,611

PARKER-HANNIFIN CORPORATION

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Cleveland, OH 44124-4141

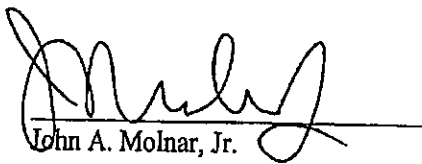
Voice: (216) 896-2212

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E-mail: jmolnar@parker.com

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited on March 10, 2004, with the United Postal Service as first class mail in an envelope addressed to: Mail Stop Non-Fee Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.



John A. Molnar, Jr.